
Digitized by the Internet Archive
in 2022 with funding from
Kahle/Austin Foundation

https://archive.org/details/agriculturalexpe0000unse_q9x4

UNIVERSITY OF ARIZONA
630.72
I 39b
LIBRARY

1-43
1906-1911 Ag

LIBRARY

PURDUE UNIVERSITY

Agricultural Experiment Station

CIRCULAR No. 1.

LaFayette, Ind., October, 1906.

HINTS ON PREPARING FOR AND HOLDING LOCAL CORN SHOWS.

By A. T. Wiancko and M. L. Fisher.

This circular is prepared with a view to answering the leading questions that come to us concerning the holding of local corn shows, and the selection and preparation of exhibits of corn for show purposes.

The growing interest in corn improvement and the desire manifested by leading people in every community to hold corn shows, with a view to fostering competition and thereby encouraging farmers to produce better types of corn, is highly commendable and must be looked upon with favor by everyone who believes in working for higher and better things, and who sees the possibilities in corn improvement.

The local corn show, if properly conducted, is a powerful factor in drawing attention to what good corn is, and may be made very convincing. A poorly conducted show, however, or one where ultimate improvement of quality is not placed and kept clearly to the front, may do harm, and result in discouragement and scepticism. Experience has abundantly proven that a good corn show is a good object lesson and a good thing in furthering other work aiming at corn improvement.

Selecting Corn for Exhibition.

In selecting corn for exhibition, it should always be borne in mind that the primary object in all corn judging and corn scoring is to select the corn that would be best for seed purposes. The best seed ears should therefore be selected, and purity, vitality, uniformity and adaptation to local farm conditions must be carefully considered.

Before selecting corn for an exhibit, study the requirements of the score card and the standard for the state, in order to have a definite ideal in mind. Having an ideal in mind, the next thing to do is to select an ear of corn embodying this ideal. Then pick out a large number of ears that approach this ideal and place them on a table or other convenient place. Go over them several times, picking out those ears that do not conform to the ideal. In this way the number of ears will be gradually reduced to the required number and a greater uniformity in the exhibit will be obtained. Uniformity is important, and no pains should be spared to make the exhibit uniform in size of ears, shape, color, butt and tip filling out, size of kernels, spacing between rows, indentation, etc. Maturity is important, and all the ears should be well matured and dry. Select ears having a bright, fresh color of grain and cob. Ears of a medium size for the locality, having a right proportion of length to circumference, are better than extra large ears. A mistake is often made by selecting for size alone, resulting in coarseness, immaturity and utter unsuitability for seed purposes.

The illustrations on pages 12 and 13 will help to show what is required. Fig. 1 shows an exhibit of excellent quality, and it would be hard to find better seed corn. Fig. 2 shows an exhibit possessing few good qualities. The ears are ununiform, irregular, mostly poor in shape, with many irregular and undesirable kernels, and in every way show a lack of good breeding and careful selection.

These illustrations will also be found useful in studying the various points of the score card which are explained on the following pages.

How to Score Corn.

At a meeting of the Indiana Corn Growers' Association at Indianapolis in January, 1905, the following general standard for dent corn in Indiana was adopted:—

A perfect ear of corn should be cylindrical, or nearly so, in shape. The length should be not less than eight inches and the circumference should be three-fourths of the length. The rows should be straight and not less than sixteen in number. The kernels should be well formed, uniform in size and shape and not more than seven to the inch in the rows. The proportion of corn to cob should be not less than 86 per cent.

The points of the Indiana score card and their values are as follows:—

	Points.	Value for 10 ears.	Value for 1 ear.
1.	Trueness to type, or breed characteristics,	10	1.
2.	Shape of ears,	5	.5
3.	Color of grain and cob,	10	1.
4.	Seed condition,	10	1.
5.	Tips of ears,	5	.5
6.	Butts of ears,	5	.5
7.	Kernel uniformity,	10	1.
8.	Kernel shape,	10	1.
9.	Length of ears,	5	.5
10.	Circumference of ears,	5	.5
11.	Space between rows and between kernels at cob	10	1.
12.	Proportion of corn to cob.	15	1.5
	Total	100	10.

Scoring Ten Ears.

In scoring corn, ten ears are usually made the basis of work; 1st., because with a number of ears in the exhibit, the judge can more accurately determine the exhibitor's knowledge of the breed or type; 2nd., ten ears makes a convenient number with which to use the divisions of the score card.

The following is the form of score card adopted by the Indiana Corn Growers' Association:—

42348

Official Corn Score Card.

Name of Variety_____ Table No._____

Name of Scorer_____ Sample No._____

		1	2	3	4	5	6	7	8	9	10
1. Trueness to Type or Breed Characteristics	10										
2. Shape of Ears	5										
3. Color of Grain and Cob	10										
4. Vitality or Seed Condition	10										
5. Tips of Ears	5										
6. Butts of Ears	5										
7. Kernel Uniformity	10										
8. Kernel Shape	10										
9. Length of Ears	5										
10. Circumference of Ears	5										
11. Space Between Rows and Kernels	10										
12. Proportion of Corn to Cob	15										
Total - -	100										

REMARKS AND REASONS FOR CUTS:

Explanations of Points and Rules for Judging.

Note A.—Cuts.—Where the amount of cut for defects on any point is not specified, the scorer must use his best judgment and score accordingly.

Note B.—Disqualifications—Any exhibit showing one or more cobs of any color other than what is evidently the standard of the variety, should be disqualified. One or more ears having a majority of kernels that evidently would not grow, should also disqualify the exhibit.

1. *Trueness to Type.* Unless the class judged is made up of one of the pure-bred varieties for which a standard has been fixed, the general standard for the state should be applied to all exhibits. Whatever the color, the ears should be all of the same shade. The ears should all be shaped alike, approaching the recognized standard. They should all be uniformly large, or uniformly small, or all medium. In determing the value of an exhibit on this point it is best to put together all ears that are uniform and mark the exhibit as many points as there are uniform ears.

2. *Shape.* The shape should approach the clyindrical, which will indicate that the depth of kernel is maintained from butt to tip. Again, put together all the ears having a good shape and mark the exhibit as many half points as there are well shaped ears. To this add as many tenths as the judgment indicates that the remaining ears are worth.

3. *Color.* Two things are to be looked for here, namely, color of cob and color of grain. White corn should have white cobs, and yellow and mixed corn red cobs, but there are exceptions to these conditions. However, the color of the cob should be uniform for all the ears in the exhibit. For every ear having a cob off color, cut the exhibit one point. Varying shades of color must be cut according to judgment.

The kernels on each ear should be closely scanned for indications of crossing. This is indicated by white crowns or other variations from the solid color in yellow corn. In white corn mixture is indicated by off-color chiefly below the crown of the kernel. For one or two crossed kernels on an ear cut it one-fourth point; for three or four, cut one-half point; for five or six,

cut three-fourths point, and for more than six, cut an ear a full point. All of the ears of an exhibit should be of the same shade of color. If the color is variable without distinct evidence of crossing, a deduction should be made according to judgment, because such variableness is an indication of lack of purity in breeding.

4. *Seed Condition.* This is an important matter and every ear should be examined for evidences of weak or destroyed vitality. Pick out two or three kernels from each ear and examine the germs by cutting them out with a pen knife. The germ should be creamy-white in color and rather brittle in texture to be a good one. If an ear is found with dead germs its full value should be deducted. When the skin over the germ, or on the back of the kernel, is wrinkled or blistered, it indicates weak vitality, and an ear having such kernels should be scored accordingly. The backs of the kernels should be clear in appearance and full at the tip. If there is a whitish streak up through the middle, or if the tip is sunken, the vitality is apt to be poor and such ears should not have full marking. Broken tips or the adherence of bits of chaff are also indications of immaturity and should be scored accordingly.

5. *Tips.* While the ideal tip is one completely capped over, it is not essentially the best tip and too much importance should not be attached to such a condition. The tip having regular rows with well formed kernels carried well out to the end of the cob is regarded as the best. The standard calls for a cut of a half point for each cob exposed one inch; for other irregularities cut from one tenth to one half point. A tip on which some of the rows do not run to point of ear or which has irregular rows or poorly shaped kernels should have a severe deduction made. Regularity, size and depth of kernels are most important.

6. *Butts.* The ideal butt is one that has the rows running well out to the end of the cob so that there will be few irregular kernels. The kernels should extend out well over the end of the cob so as to form a rather deep depression in the end of the ear when the shank is removed. The shank should be medium in size, so as not to be difficult to break off when husking. Irregularities at the butts are cut according to judgment from one tenth to one half a point.

7. *Uniformity of kernels.* In judging kernel uniformity, three or more kernels should be removed from each ear and laid in front of it to show their shape and depth. Two kernels should be taken at about one third of the distance from the butt and one or two kernels at about two inches from the tip. Mark the exhibit as many points as there are groups of kernels uniformly alike in shape, size and indention. The kernels of any ear should also be uniform as compared with each other.

8. *Shape of kernel.* A well shaped kernel should be considerably longer than it is wide, say one and a half to two times. The thickness should be the same throughout from crown to tip. The edges should taper very gradually from crown to tip, but should not come to a point. There should be a distinct shoulder at each side of the tip, giving room for a well developed germ. Examine the groups of kernels that were removed for Point 7 and mark the sample as many points as there are groups having a good shape.

9. *Length.* Since the Indiana standard says that an ear should not be less than eight inches in length, it follows then that every ear having that length, or more, should be marked full. The length is best measured by a foot ruler, but may be measured with a tape line. The greatest possible length from butt to tip is taken. Should any ears fall short of eight inches, then the deficiencies are added together and a deduction made at the rate of a half point for each inch of deficiency.

10. *Circumference.* The circumference should be three fourths of the length. If an ear is ten inches long, its circumference, measured at about one third of the distance in from the butt should be seven and one half inches. Suppose in measuring the ears three of them should be each a half inch too large and four of them each a half inch too small, while the remainder are each in right proportion, the aggregate defect would be three and a half inches, and deducting on the basis of a half point for each inch of defect, the cut would be 1.75, leaving the score 3.25.

If the exhibit being scored is in a pure bred class of one of the varieties for which there is a fixed standard of length and circumference then that standard is applied on these two points,

but deductions are made on the same basis as for the State standard.

11. *Space between rows and kernels.* The value of this point should be divided between the space at the cob between kernels and the space between rows at the surface. However, if either is very bad, the full value of an ear may be deducted for that defect.

To determine space between kernels at the cob, examine the kernels already removed. The shape of the tips will be indicative of the space likely to be found at the cob. Also, examine kernels on cob at the point where kernels have previously been removed. Space between kernels near the cob in either direction is highly objectionable, because it shows that the kernels are shrunken, too thin at the tip, or too pointed, indicating low vitality, low feeding value, and low proportion of corn to cob. Too much space between rows at surface of ear indicates kernels of poor shape. They should be shaped so as to touch from the tip to near the crown, that is, they should be square shouldered, but the rows should not be crowded. A crowded condition hinders drying and may cause moulding. Examine each ear and mark the exhibit according to judgment.

12. *Proportion of corn to cob.* This point can be determined accurately only by shelling and weighing. It can be estimated by taking into account the shape and depth of kernel, the filling out of butts and tips, the size of cob and degree of maturity. However, several ears should be shelled and weighed so as to get an idea of the variations under different conditions. First, weigh the ear, then shell and weigh the grain. The grain should weigh 86 per cent. of the whole ear. Deduct one and a half points for each per cent. below standard.

Scoring a Single Ear.

In scoring an individual ear, the same procedure is gone through with as in scoring ten ears. In making Point 1, it will be necessary to have in mind a typical ear. This should conform to the general standard. To the points of the general standard should be added, kernel indentation, which should be such as to

give the ear a medium degree of roughness. The dents should be of uniform depth across the kernels, and without jagged or pointed edges.

If the ear judged is in a class of a pure-bred variety, it should be marked according to its agreement with the standard for that variety.

In Point 7 the kernels of the ear should be compared with each other and with the General Standard or the standard for the vareity. If there are irregular rows or poorly shaped kernels, the ear should be marked down accordingly.

Judging at a Corn Show.

The judging at corn shows must usually be done rapidly and very often the time allowed the judge is altogether too limited for careful work. If there is sufficient time, the judge should score each exhibit entered for a premium. At corn shows in connection with Schools, Corn Clubs, or Farmers' Institutes, the score should be attached to each exhibit, thus emphasizing the educational value of such shows. When the time for judging is limited and all that is required is to place the best samples, the judge may first roughly examine all the exhibits, selecting out those that may possibly be among the prize winners, and then use the score card to place them correctly.

If premiums are offered for the best corn without specifying color, the judge does not discriminate between colors, but judges each exhibit according to the purity and uniformity of its particular color.

Where premiums are offered for best white, or best yellow, or best other color, the judge selects the best exhibits in each class regardless of variety. Where sweepstakes premiums are offered the winners in the various classes are pitted against each other, regardless of color or variety.

The disqualification under Note B, page 5, should be strictly enforced, and ears entirely off in color of cob or evidently dead should bar any exhibit from winning a premium.

Standards of Some Indiana Varieties.

Variety	Length, inches.	Circumference, inches.	Proportion grain to cob, %
Early Yellow Dent,	9	7	88
Gold Mine,	9	7	88
Riley's Favorite	9	7	90
Reid's Yellow Dent,	10	7	88
Golden Dent,	9.5	7	88
Leaming,	10	7.5	88
Johnson Co. Yellow Dent	10	7.5	88
JohnsonCo. Gold Mine	10	7.5	88
Gold Standard,	10	7.5	88
Silver Mine,	9	7	90
Boone Co. White,	10	7.5	86
Pride of Indiana,	10	7.5	88
Johnson Co. White Dent	10	7.5	88
Vogler's White Dent,	10	7.5	88

The Corn Show.

Time. Corn exhibitions should not be held too early in the season. Corn should be mature and dry before being put on show, for in no other condition can a judge render just awards. Earlier than September 20 is hardly desirable in any part of Indiana.

Place. Good light is all important. Plenty of room is desirable so that the exhibits may be inspected with ease by spectators.

Arrangement. Arrange the exhibits into classes, white, yellow, mixed, and special, each in a distinct place. Place the exhibits on tables or benches high enough to be examined easily. Give each exhibit room enough so that the ears will not need to be piled up. For the convenience of both judge and spectator, all exhibits should be laid out flat.

Size of exhibits. Ten ears is the standard sized exhibit and permits the use of the score card to the best advantage. The exhibit should be labeled with a card upon which is a number corresponding to the number given the exhibitor at the time of entry.

Judge. Select for judge a man who has a wide experience in handling corn as well as a working knowledge of the score card and its requirements. The secretary of the Corn Growers' Association can furnish a list of men who have met the requirements of the Association for an expert judge's license.

The judge should be on the ground in sufficient time to be able to give careful attention to each lot of corn before making his decisions. It frequently happens that a judge does not have time enough to do justice to his work. If the number of exhibits is large, it will be better to have the judge at his work the day before the awards are to be announced. The judge should have as much privacy as possible while at his work. It is not possible for him to do his best work if he is being talked to and interferred with by the spectators.

Premiums. It is better to give a large number of premiums of moderate value than a few of considerable value. There will be opportunity for more persons to receive something, and in this way keep up interest in the work.

Disposition of Exhibits. All exhibits should remain the property of the exhibitors. In this way only will they display their best corn, if they attach any importance to good seed.

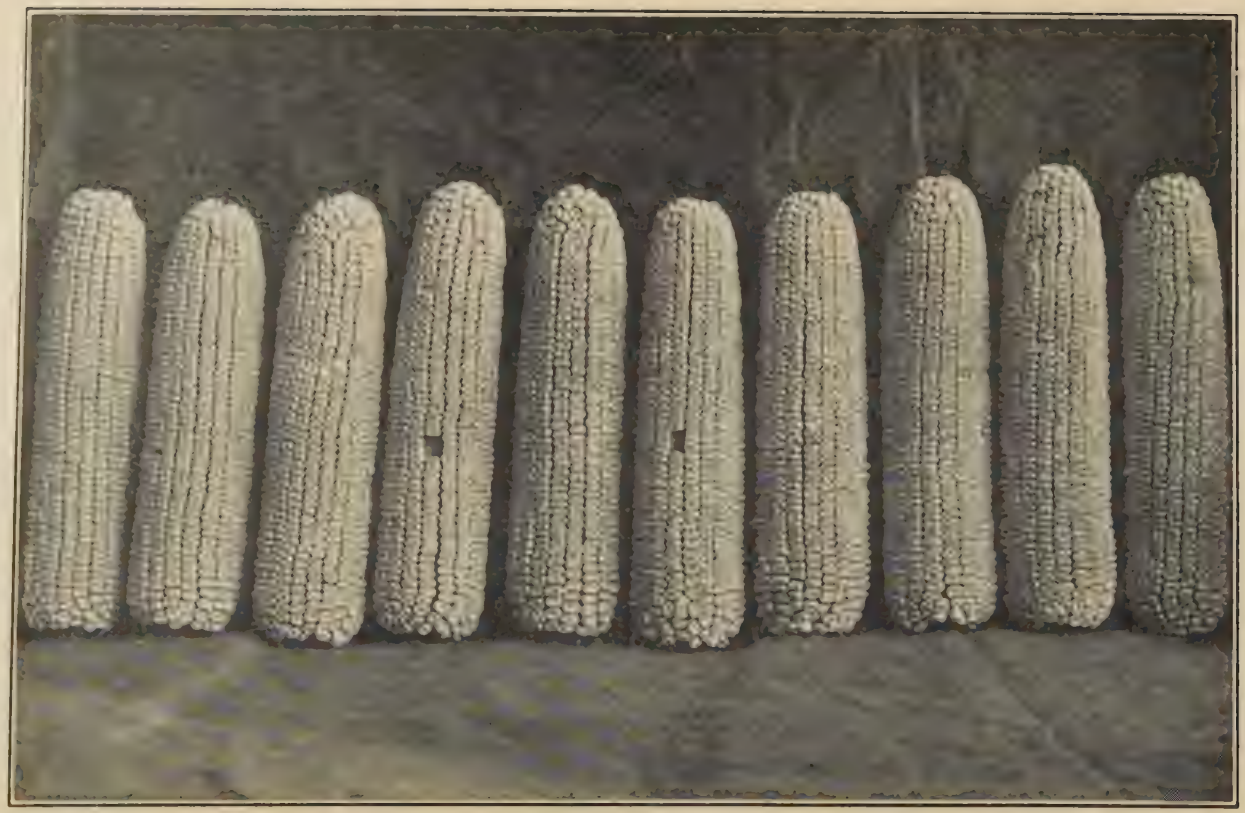


Fig. 1. A fine exhibit of excellent ears, every one of which would make good seed.

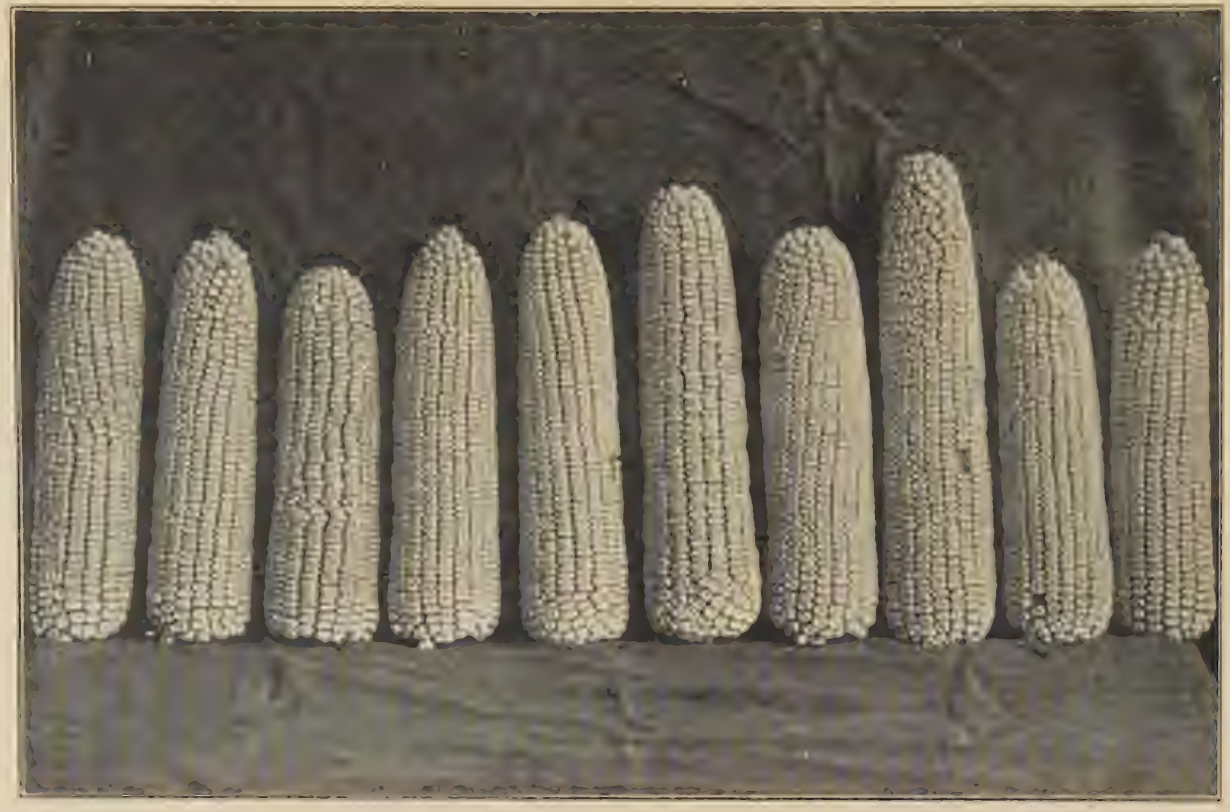


Fig. 2. A poor exhibit, without a single good seed ear in it.

Purdue University
Agricultural Experiment Station

CIRCULAR No. 2
SECOND REVISED EDITION

LaFayette, Ind., March, 1908

THE SELECTION, PRESERVATION AND PREPARATION OF SEED CORN

By A. T. Wiancko and G. I. Christie

An enormous loss, amounting perhaps to several millions of dollars, is sustained each year by the farmers of Indiana through lack of proper attention to the selection and preservation of their seed corn. With the 4,000,000 acres of corn annually produced it does not take many bushels per acre to amount to an aggregate of many millions of dollars worth of corn. There is abundant evidence which shows that the average farmer does not secure more than about three quarters of a full stand of stalks in the field, while it is easily possible to have 95% of a full stand, and there can be no reasonable excuse for less than 90%. The farmer who has less than 90% of a full stand of corn has made some serious mistake, and it is generally simple carelessness, for which there is no reasonable excuse. Every community has examples of farmers who secure a good stand of corn every year and whose yields are always away above the average. Why are there not more getting such results? Is the difference due to condition of soil and cultural methods alone, or has the successful man also taken care to use only good seed and thus insure the best possible stand of plants? A poor stand is generally evidence of poor seed and the last part of the question can be easily answered by making a count of the stand. Well prepared soil, a sufficient supply of plant food and careful culture are of the utmost importance in successful corn production, and need to be kept in mind and emphasized, but good seed is also necessary and is much more important than the average farmer be-

lieves. Looking at the matter of stand alone, it does not require much mathematics to show that with a ninety per cent average stand instead of seventy-five, our average yield would be raised by over ten bushels per acre without any improvement in any other condition. How much the yield might be increased by the use of only well bred and carefully selected seed is a question that is harder to answer, but experiments show that good seed, of a type of corn suited to the soil and climatic conditions where it is to be used, will produce much better results than the seed now used by the average farmer.

The table shows the conditions in a few of the poorer and better fields among several hundreds examined by the Station in various parts of the State and strongly emphasizes the importance of carefully selecting, testing, and grading the seed for planting.

Field No.	Per Cent of Stand Found	Per Cent of Barren Stalks	Per Cent of Ear Producing Stalks
181	46.6	6.	**43.8**
113	47.8	2.	**46.9**
96	50.1	3.	**48.6**
48	52.8	9.	**48.1**
12	55.1	15.	**46.9**
56	97.0	3.	**94.1**
26	99.6	5.	**94.6**
66	99.7	3.	**96.7**
Average of All Counts Made	**71.7**	**3.2**	**69.4**
*155	95.6	2.	**93.7**
*156	60.0	4.	**57.6**

*Two fields on the same farm. No. 155 was planted with properly selected and tested seed, No. 156 with seed selected from the crib in the spring.

When and How to Select Seed Corn.

All seed corn should be selected directly from the stalk. A little thought will show any intelligent corn grower that the best seed can be secured only by field selection, because the character of the stalk upon which the ear is produced is of great importance.



Figure 1. The stalk to the left is a good one and bears its ear in proper position; on the second the ear shank is too long and coarse; on the third the ear is held too upright and is too high up; the fourth stalk has a number of large suckers.

After the corn is mature and some time before the general husking begins, take a basket or sack and go through the best portions of your corn field and select good looking, well matured ears that are held in good position on clean, thrifty looking stalks that stand up well, have a good leaf development, and are of medium size. The ears selected should be of a size suitable for the local conditions. There is a limit to the size of ear that can be expected to ripen in an average season. *Many farmers make*



Figure 2. Selecting seed corn at the proper time.

the mistake of growing corn that is really too large and too late for their conditions. It often lacks in quality and they are losers in the long run.

The ears selected should be strong and symmetrically developed, with straight rows of even sized, well dented kernels. The seed ears should always be a little rougher than the average of the crop, otherwise the variety will become smoother each year and the kernels shallower. The dent, however, should run squarely across the kernel and there should be no sharp or pointed margins.

No farmer can afford to neglect this field selection of plenty of good seed ears for his own planting.

A really well selected and well preserved bushel of seed corn may be worth $25.00 more in its producing power than a bushel selected from the crib in the spring, when we consider that it may easily give us ten bushels more per acre in the crop it produces.

The quantity of seed corn selected from the field should always be considerably more than will be required for planting, so as to leave room for more critical selection later on.

It is poor business practice to leave the seed corn selection until the general husking, when every time you stop to examine an ear you keep a team and perhaps another man waiting.



Figure 3. An ideal system of storing seed corn.

Drying and Storing Seed Corn.

The best seed corn is that which matures and dries naturally. Much corn that is intended for seed is injured by improper methods of drying and storing. It is most liable to injury during the first month or six weeks after husking. The outside of the ear may be dry and hard but the cob and points of kernels still contain much excess of moisture, and it is this which so easily causes moulding, fermenting, growing, or injury from freezing.

As the seed ears are brought from the field they should be put in a dry, well ventilated place, and in such a way that there will be a free circulation of air around each ear. If the ears can be kept completely separated and free, so much the better. There are many good ways of storing seed corn, some of which are shown in the accompanying illustrations. One bundle of ordinary plastering laths and a few pieces of old fence boards will make a rack that will hold about six bushels of seed ears, and can be constructed in an hour or less time. Whatever the method of



Fig. 4. An inexpensive seed corn rack that will hold about six bushels of seed ears.

storing, it must be one that will provide for slow and perfect drying, with a free circulation of air. Drying by artificial heat should be avoided, if possible, as it is always more or less risky on account of damage through over heating while the corn is still moist. Natural drying is always best and, generally speaking, properly selected seed corn should not need artificial drying. After it is perfectly dry seed corn will stand any amount of cold weather, but it must be protected from dampness and any sudden or extreme changes of temperature or humidity.

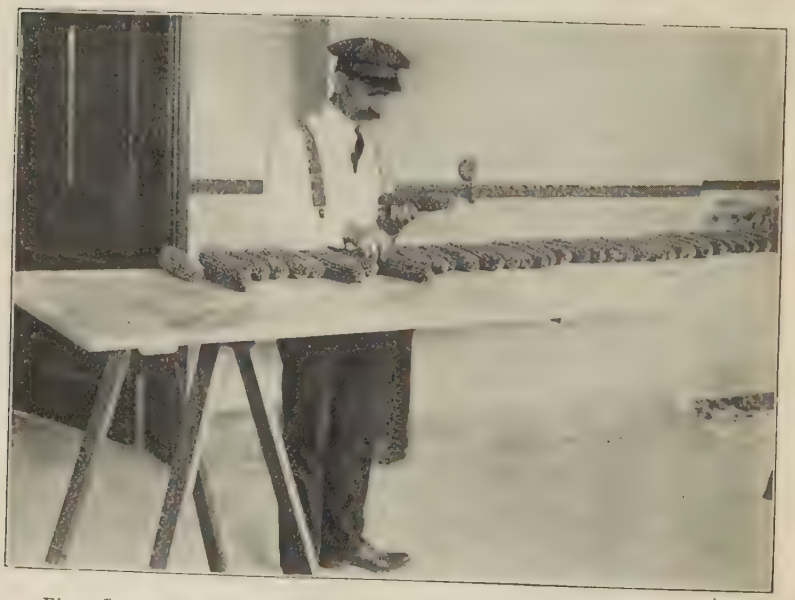




Figures 5 and 6. Commendable methods of drying seed corn.

Final Selection of Seed Ears.

In early spring, all the seed corn must be carefully examined, culled, tested and reculled so that only the best may go to the planter. Before the outdoor work begins to press for time, this final selection of seed corn can be made comfortably and it should not be delayed beyond the middle of March. A good way to proceed is to lay the ears out in rows on a table in a well lighted place and go over them one at a time, throwing out all that are defective in any way. It is a good plan to hold a specially fine ear in one hand, as a sort of pattern to select to. Examine the illustrations on pages 12 and 13. Fig. 9 shows a carefully selected, beautiful lot of seed ears, while Fig. 10 shows a carelessly se-



Fisure 7. Critical selection of seed ears before testing the germinating power.

lected lot. Plenty of time should be given to this work. It will be repaid many times over. After this careful selecting and culling, the seed is ready to be tested for vitality.

The Germination Test.

No farmer can afford to neglect testing the vitality of his seed corn, no matter how carefully it has been stored. There are so many ways in which the vitality of seed corn may be in-

jured that it is never safe to assume that all of it is in good condition. There may not be a single ear that will not grow, but there are very likely to be odd ones that are weak, and these are the ones which the germination test will help to weed out. Any one familiar with corn can detect a dead germ and pick out the ears that have been fatally injured, but *a weak germ cannot be detected by any other means than the actual germination test.* Every weak ear that goes to the planter means several hundreds of weak plants, or vacant spaces in the field, and a corresponding loss in yield.

The germination test may be made in various ways, but in all cases *each ear should be tested by itself.* Experiments have amply shown that as a rule the testing of a few kernels, picked at random from different parts of the ear, will safely determine whether or not the ear should be used for seed. The individual ear test is the only means of finding out which are the poor and which the really good ears.

The requisites for germination are moisture, warmth and air. Any convenient receptacle in which these can be provided will answer the purpose.

A Good Tester.

A convenient tester, and the kind we would strongly recommend every farmer to use, is shown in Fig. 8. It consists of a wooden tray about two inches deep, two and a half feet long and two feet wide, strung with light fence wire, one and three quarter inches apart each way, and an inch and a half above the bottom, and filled up to the wires with moist sand. The cross wires permanently mark off the surface of the sand into one and three quarter inch squares. Each square serves to hold the kernels to be tested from a single ear. If much corn is to be tested several of these testers should be provided. They are easily made and with good care will last for many years. For the average farmer one will be sufficient, as about three bushels of seed ears can be tested at one time.

When making tests, some convenient system of arranging the ears on a rack, table or floor must be employed, so that the ear corresponding to a certain square in the tester may be readily located. The test should be made with about five kernels per ear, as shown in Fig. 8, and they should be taken from various parts of the ear. One should look out for elevated or swollen spots when selecting kernels for the test, because wherever these occur the cob is probably more or less spongy, and retained moisture after the rest of the ear was dry and out of danger of being injured.

After the kernels have been placed, the material in the tester must be kept thoroughly moist. Sand is preferred because it is clean and easily kept in good condition. The kernels should be pressed well into the sand, but they need not be buried out of sight. The important thing is to keep them thoroughly moist. Some kind of cover for the tester must be provided, so as to keep the surface from drying. A couple of panes of window glass make the most satisfactory cover. With the glass cover, the soil needs to be moistened only once for each test, as the evaporated moisture will condense on the under surface of the glass and drop back on the soil. The cover should not fit too closely, as the germinating kernels must have quite a lot of air. When moistening is necessary after the kernels have been placed, a towel

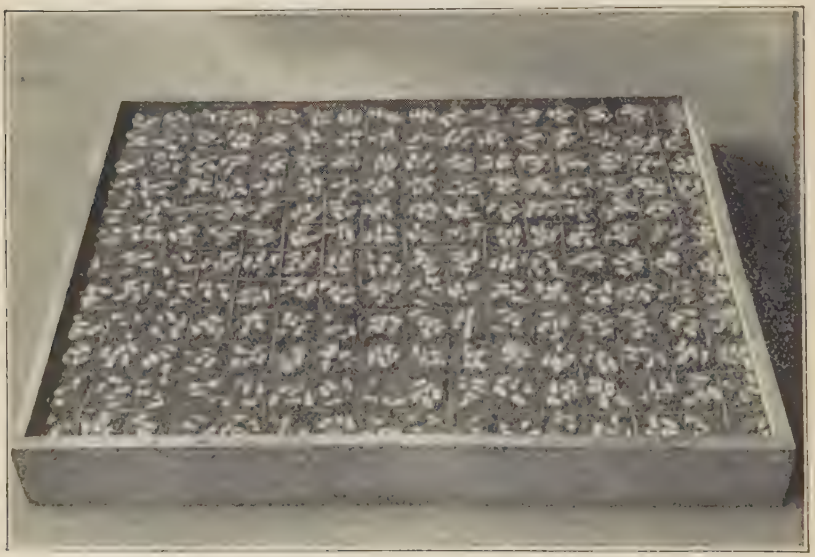


Figure 8. A filled tester ready to be covered and set aside for germination.

or other cloth should be spread on the surface, and the water poured gently on top. If this is not done, the water poured on will move many of the kernels out of place.

The filled tester should be placed in a room where the temperature ranges around 70 degrees F., but not too near the stove. The ordinary living room is about right, provided that it does not become colder than 55 degrees during the night. *All kernels which do not send out vigorous root and stem sprouts within four or five days, under these conditions, should be considered as too weak to germinate properly under ordinary field conditions and the ears from which they came should be discarded.*

TABLE SHOWING RESULTS OF GERMINATION TESTS OF CORN INTENDED FOR SEED.

	No. of ears tested	Percentage of ears germinating:— 100%	80%	60%	40%	20%	0%
Highest Testing Lot	261	**98.5**		1.5			
Lowest Testing Lot	1231	**22.7**	28.7	23.6	15.4	7.3	2.4
Average of 46 lots of ears from different sources	19751	**51.1**	25.0	12.8	6.6	2.88	1.42

The above table very conclusively shows that much of the corn that is sold for seed is utterly unfit for use, and that testing should not be neglected.

PREPARING THE SEED FOR PLANTING.

After the seed ears have been properly selected and tested, they are ready to be shelled and the grain prepared for planting. The small and irregular kernels at the tips of the ears and the large irregular ones at the butts must be shelled off first and discarded. Irregular kernels in the body of the ear should also be discarded as completely as possible so that only those kernels which are of uniform size and shape may go to the planter. This discarding of the small tip, large butt, and other irregular kernels is very important because it is impossible for any planting machine to always drop the required number of grains per hill if they are not of the same size and shape. Many a poor stand of corn is due solely to ununiform seed.

Each ear should be shelled by itself and the grain spread out thinly and carefully examined for broken, mouldy, or otherwise damaged kernels. It is a good plan to use a set of screens of two sizes through which to pass the shelled corn, discarding that which is retained on the larger and that which passes through the smaller. When seed of uniform size must be used, it should be graded into larger, medium, and small sizes, and a suitable planter plate used for each.

There are now on the market a number of simple machines for grading seed corn which are very useful when large quantities of seed are to be graded, but for the farmer who has only a few bushels of seed to prepare, the eyes and the hands are the best graders.

The following table further emphasizes the importance of careful grading, showing the results of dropping tests with graded and ungraded corn. It was desired to plant three kernels per hill and the table shows the best results that could be secured in each case.

RECORDS MADE IN 100 DROPS.

No. of Kernels Dropped	Middle Kernels Only	Whole Ear	Deep and Shallow Kernels Mixed	Deep Kernels Only	Shallow Kernels Only
1		1 time			2 times
2	8 times	6 times	5 times	4 times	2 "
3	92 "	66 "	75 "	92 "	95 "
4		25 "	18 "	4 "	1 time
5		1 time	2 "		
6		1 "			

It will be seen that when the large, irregular kernels from the butt of the ear and the small ones from the tip were mixed with the more uniform kernels from the middle of the ear, it was impossible to get anything like a satisfactory stand, and the same was true when deep and shallow kernels were mixed. But when the butt and tip kernels were discarded and the deep and shallow ones separated an almost perfect dropping was secured in both cases.

TESTING THE PLANTER.

Having graded the corn and made it as uniform as possible, we must next find the set of planter plates that will drop the required number of kernels at least 95 times in every hundred. The planter should be set up in a convenient place and operated by hand, running through a sample of the corn to be planted and using plates with different sized openings until the pair is found that will drop the desired number of kernels every time, if possible. If the best plates available are not quite satisfactory, they must be filed or drilled until they do the work as required. All up-to-date planters are supplied with a number of plates of different sizes, so that it is only necessary to select the right set for the corn to be planted.

To some of our readers it may appear that what we are herein recommending is a little too much trouble, but they may rest assured that the matter has been carefully investigated and tested and that it will pay well to give such careful attention to the selection and preparation of corn for planting.

Directions for Planting and Conducting a "Seed Corn Patch,"

1. Select twenty-five of the best and most typical ears of corn from the seed which you aim to plant this year.

2. Make a germination test of each ear, in order that no weak ears may be planted.

3. Shell off and discard the small and irregular grains from the tips and butts of the ears.

4. Shell the ears together and mix thoroughly.

5. Test the planter with this corn, and adjust the plates until the desired number of kernels can be secured ninety to ninety-five times out of the 100 drops.

6. At the usual time of planting, plant this corn on the south or west side of the field to be planted with the same variety.

NOTE—Do not plant on south or west side if that is near a cornfield planted with another variety.

7. Give usual good cultivation, keeping the ground free of weeds, and preserving a loose soil mulch.

8. After the corn is five or six inches high, go through the patch and remove all the weak and backward plants.

9. When the tassels begin to appear, remove them from all stalks which are either weak, barren, smutted, badly suckered, or for other reasons undesirable.

10. When the corn is mature, and not later than October 15th, the seed should be harvested. These seed ears should be taken only from the strongest stalks, and those bearing the ear from four to five feet from the ground, and holding it in the right position.

11. The corn should be put in a dry place, where each ear will be subjected to a constant circulation of pure air. It should be thoroughly dry by the first of December, and should be protected throughout the winter from all sudden or extreme changes of temperature or humidity. **It Must be kept above the freezing point until thoroughly dry.**

NOTE—For more complete instructions concerning the selection of seed corn, explanations and illustrations of the points of the corn score card, and directions for conducting corn breeding work according to the individual ear and row method, write to the Station for Bulletin No. 110, "Corn Improvement."

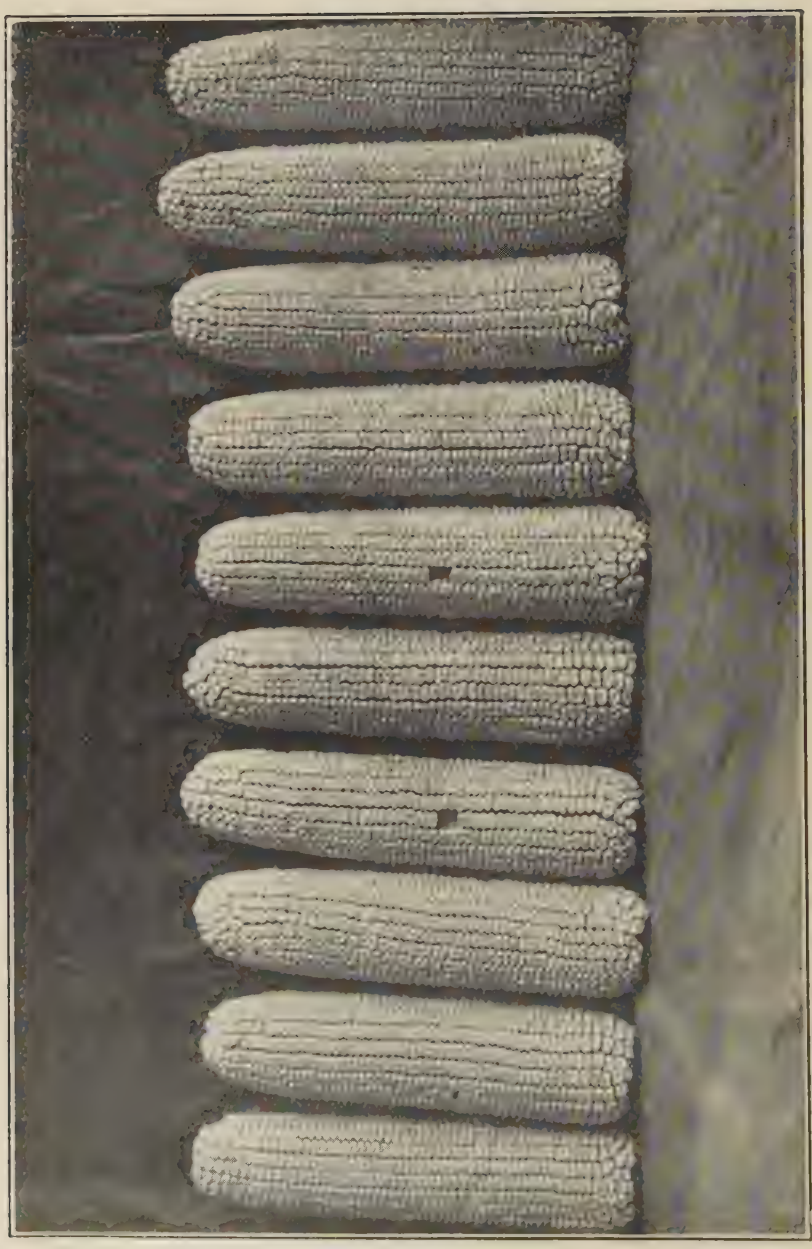


Fig. 9. A fine uniform lot of seed ears.



Figure 18. A haphazard selected lot of ears, mostly of poor type and condition in every respect.

PURDUE UNIVERSITY

Agricultural Experiment Station

CIRCULAR No. 3.

LaFayette, Ind., December, 1906.

CORNSTALK DISEASE.

By R. A. Craig.

When cattle are first changed to the stalk fields and begin feeding on the stalks and the poor corn left in the fields, loss from disease occurs as a result of the change in the diet and from other causes. Such acute diseases as impaction, bloating, etc., are not uncommon, but in some years the greater part of the loss is not due to this class of disorders. In the fall and early winter of 1901-'02, cattle feeding in the stalk fields of Indiana died of a disease commonly called cornstalk disease, and a milder form of apparently the same disorder occurred in the seasons of 1905-'06. This disease was most prevalent in the central portion of the state.

The disease was first reported in November. An outbreak occurred in the neighborhood of Mulberry, and the general supposition was that it was caused by the cattle eating the moldy, spoiled corn, as a larger quantity than common had been left in the fields. Later, the Experiment Station received a few reports and inquiries from stockmen and veterinarians in other sections of the State. In order to get further information regarding the nature and prevalence of this disease, a letter of inquiry together with a list of questions was sent to the practicing veterinarians.

In answer to the question regarding the prevalence of cornstalk disease a number of veterinarians stated that it was prevalent in their locality, but reported very few cases as treated. Altogether about one thousand cases were reported and more than half of these were, without doubt, the disease in question. Most of the cases reported occurred during November and December. About one hundred of the affected

animals died. A large percentage of the deaths were in Allen and Clark counties. In the former county out of seventy cases there were twenty-three deaths, and in the latter, one hundred cases and forty deaths. In Clark county the disease began in August and continued until the latter part of March, and the symptoms and history given were not typical of cornstalk disease.

The following cases were reported by Dr. N. B. Combs, Mulberry, Indiana:

"During November, December and January, I treated sixty-five head of cattle, mostly cows, that were affected while pasturing in the stalk fields with a disease presenting a nervous train of symptoms. In most cases the disease responded readily to treatment and only a few of the affected animals died.

"One of the first cows treated had been pasturing on stalks for a week and a half, when the owner found her down in the field and unable to get up. I visited the farm an hour afterward and found the cow up and coming toward the barn. Her gait was uncertain and staggery. At times she appeared delirious. Spasms occurred and she would fall down and remain rigid for about half a minute. In one of these spasms she fell against the fence and remained in a half standing position until the muscles relaxed, when she dropped to the ground. She was given treatment but no noticeable improvement occurred until the third day. From this time on her condition gradually improved, and on the tenth day the recovery was complete.

"The day following my first visit three other cows in the herd (eight head) showed about the same train of symptoms as the first. One animal became paralyzed on one side of the body. All made a good recovery in about a week. These cattle were turned into the stalk field later and no further trouble occurred.

"In another herd that had been on stalk pasture for about two weeks a cow became paralyzed in her hind parts after showing an uncertain gait for three days. I was called and found her down, somewhat delirious and at times struggling violently, followed by spasms of the muscles. The cow did not improve and died six days after going down. Two other cases occurred in this herd. The symptoms shown were a staggering gait, partial loss of appetite and lessened milk secretion. All of the latter cases were mild and recovered in about four days.

"In a third outbreak the cattle had been pasturing on the stalks ten days before any of the animals were affected. One cow was found down and unable to get up. She remained quiet and in a natural

position unless disturbed. When slapped on her side or an attemp made to administer medicine, a severe spasm occurred, usually so violent as to make it impossible to administer treatment. On the following night the cow died and was cremated by the owner without reporting to me, hence an opportunity to make a postmortem examination was lost. This was the second death on this farm, a calf two months old having died a few days previous to my first visit. This animal had eaten shelled corn from the shredder that contained much mold. It also showed nervous symptoms. At the time of my visit I looked the herd over and found three cases of the disease besides the one that died, and three additional cases developed later. All recovered in from four to eight days. Two of the animals at times showed complete loss of control over the movement of their fore parts, causing them to fall and slide along on their briskets. Two weeks later the herd was turned into the same field and they were again affected. The symptoms this time were very mild.

"On an adjoining farm and at a time the above animals were affected, three cows showed symptoms of the same character. These cows were down when I first visited them. Two improved rapidly and in three days were on their feet. The third showed marked general improvement but could not support weight on her hind limbs. She continued in this condition for several weeks and was finally killed. Within a few days after the disease developed the herd was returned to the stalk field and no further trouble occurred. In about four weeks the cattle were turned into an adjoining field which had not been pastured, and on the fourth and fifth days after changing fields three of animals were affected and showed the usual train of symptoms. The herd was returned to this field a little later and the disease did not recur. After pasturing here for a few weeks they were turned into a new field of stalks the last week in December, and the first week six new cases developed. All made a recovery. Weakness and knuckling over in the posterior fetlock joints were especially noticeable in the latter cases. However, these symptoms occurred in a number of the former cases.

"The body temperature of the diseased animals remained about normal throughout the attack. In several cases faeces were passed at frequent intervals, and were, perhaps, more soft than common. None of the cattle had a diarrhoea. A number of the animals that were affected did not thrive well for several months, and late in the spring (May) did not appear as thrifty as the cattle that had not been affected. Knuckling over in the fetlock joints was still shown by a few animals."

The following cases were reported by Dr. A. R. Thompson, Attica, Indiana:

"During the months of December and January I treated a number of cattle that were affected with what appeared to be a new type of cornstalk disease. In most cases the animal had a good appetite, the body temperature remained normal or sub-normal, and no symptoms of a digestive disease were manifested. The symptoms were of nervous character, such as a staggering gait, falling down and getting up again, eyes staring, pupils dilated and finally paralysis. All of the cattle were pasturing on stalks.

"The following is a brief summary of the symptoms shown by a few of the cattle that I was called to treat.

"A bunch of twenty-five yearling steers had been running in a stalk field about two weeks when I was called to treat two of them. One showed the usual staggering gait, the other was down and unable to get onto its feet. Both of the yearlings made a good recovery and the herd was returned to the stalk field without further appearance of the disease.

"On another farm where I was called two cows that had been pasturing on cornstalks were affected. At the time of my visit they were both down and unable to rise. They made a good recovery. About ten days later another cow was affected in the same way as the former. Just previous to my first visit a cow 'went down' in the field and the owner, thinking that she would not recover, killed her.

"In a large herd of steers seven were affected in the same afternoon. Five of these animals were able to get up the following morning and to all appearances had recovered. The other two steers made good recoveries later.

"Only two deaths occurred among the cattle treated. These, I believe, were largely due to exhaustion and exposure, as they had been lying in the wet and mud for about twenty-four hours before discovered."

Drs. Erdel and Smith, Frankfort, Indiana, stated in answer to the letter of inquiry that they first attributed this disease among the cattle in their locality to eating dry, mouldy corn. In one instance two cows that had not pastured on the cornstalks, but were pasturing on a blue grass timber pasture, had the same disease as the cattle that were feeding in the stalk fields. The grass in the pasture was long and had fallen down.

In Bulletin No. 58 of the Kansas Experiment Station, Dr. Mayo reports an outbreak of cornstalk disease of a more fatal form, but similar in many ways to the form of the disease that occurred in this state the past year.

The outbreak occurred in a herd of seventy-five three-year-old steers that were running in an eighty acre stalk field. On the fifth day some of the cattle began showing symptoms of disease. Dr. Mayo's report of this outbreak is as follows:

"The stalk field was a mile or more from the ranch and feed lots, where all the cattle were, except six that had been left in the stalk field. Of these brought to feed lot three were down and five or six were noticeably affected, as shown by uncertain gait, lack of co-ordination and knuckling of hind legs. The steers that were down had been hauled to sheltered places and were nibbling at millet hay and eating a little corn that was given them. Their temperatures were 102 1-5 degrees F., 102 1-2, 102 1-5 degrees. The respiration and pulse were faster than normal but this was probably caused by the excitement of drawing them upon a sled. There was paralysis of the hind quarters.

"Of the steers that were necessarily left in the stalk field one was dead and six had been hauled out of the stalk field and placed on the south side of a haystack in an adjoining meadow. Two of the six had been able to regain their feet during the night and had wandered away. Of the remaining four, three presented the same appearance and condition as those at the feed lot, except their temperatures were slightly lower, 101 3-5, 102, 102 1-5. Their bodies had been covered by hay, of which they ate a little, and also a little corn that was given them. If approached they would shake their heads and make efforts to rise, but were unable to do so on account of paralysis of the hind parts. All of these steers were lying in normal position upon the sternum or "brisket." Another steer more seriously affected was lying upon the right side, and was quite badly bloated. This bloating was probably caused from indigestion induced by lying in one position on the side. Tapping the rumen gave temporary relief. This steer appeared to be in no pain. The eyes were congested and were discharging some muco-purulent matter. His temperature was 101 3-5. The dung of all the sick steers was very dark colored and foetid, yet containing quite a little undigested corn. The remaining (seventh) steer was dead. Had been dead two days, but as the weather had been cold decomposition was not marked. The steer was lying in a depression or 'draw' that contained some standing water and was quite mirey. An autopsy revealed congestion of the brain and lungs,

the latter severe. Rumen was partially filled with well masticated corn stalks. There was no impaction of the omasum (manifolds) the abomasum, or true stomach was empty of food but congested and contained a quantity of mucus. Small intestines were congested. Large intestines congested and filled with dark, foetid manure, mixed with considerable mucus. The heart was congested. The liver, spleen and kidneys appeared normal. After this steer was taken ill he was exposed to a cold sleet and snow storm and his death probably resulted from a combination of disease and exposure.

"A hasty examination of the stalks in one corner of the field failed to find any noticeable abnormal conditions, although Mr. Gregory mentioned that there had been considerable rotten corn in the field.

"Out of the seventy-five head of steers twenty were "visibly" affected, sixteen were "absolutely helpless," and ten died.

"The history and symptoms as exhibited by these cattle would indicate that they were affected by some poisonous substance which had a paralyzing action upon the nervous system, as shown by loss of control of hind parts and congestion of lungs, which indicates a weak action of the heart.

"The source of this poisonous substance, if such it be, may be in the rotten corn; something of the nature of a ptomaine or nitrogenous base formed in the decomposing corn.

Experiments Made in the Feeding of Spoiled, Moldy Corn to Horses and Cattle.

In January, 1906, four sacks of spoiled, moldy corn were gathered from a stalk field adjoining a field in which cattle had developed corn-stalk disease. A healthy heifer weighing three hundred and fifty pounds was fed from four to five pounds (twelve to seventeen ears) of this corn twice a day. In addition stover was fed. On the afternoon of the sixth day of the test the heifer appeared weak, went down in the stall and was helped up twice during the afternoon. When down she struggled some, and when helped up "shivered" as though cold. In the evening she was still trembling and appeared weak. The weakness disappeared the following day. A few days later a slight twitching of the body muscles was noticed. The feeding test extended over a period of sixteen days. Her appetite remained good throughout the test.

During the fall and early winter of 1898-'99, Bitting[1] reported losses in horses and cattle, supposed to have been due to feeding on spoiled corn. By feeding corn meal that was inoculated with a pure culture of a mold (fusarium sp.) made from the spoiled corn, he produced salivation and redness of the gums of the two horses used in the experiment. Later, spoiled corn was fed. On the fifth day one horse showed a slight salivation, colicy pains and diarrhoea. On the seventh day a noticeable incoordination in moving about and stupor. For two days the animal stood with the head pressed against the wall. A quick recovery followed and the nervous disease from which horses were reported as dying did not develop. The second horse showed nothing more than a slight irritation to the mouth.

Bodin and Gautier[2] from the study of the fungus Aspergillus fumigatus in culture and inoculation of animals have shown that it produces a toxin which may be compared with the toxins of bacteria. For the formation of this toxin in culture they found it necessary to have a mixture of protein and some carbohydrate. The symptoms of poisoning produced by the toxin were muscular convulsions followed by death within a few hours, if the animal did not recover. Among the experimental animals used, the rabbit and dog were found most susceptible to this poison.

Causes of Cornstalk Disease.

Many theories as to the cause of this disease have been advanced, but none of them has proven satisfactory. In its early history stockmen were of the opinion that eating the corn smut caused sickness and death among animals pasturing in stalk fields. The popular opinion regarding the disease producing properties of smut led to a large number of feeding tests. These tests and the observations of stockmen as well have proven beyond a doubt that corn smut in itself is not poisonous to animals pasturing on stalks.

Billings[3] attributed cornstalk disease to germ infection. The infectious germ he believed identical with a bacillus which produced a disease of corn known as "corn blight" or Burrill disease. Cultures of this bacillus from the tissues of cattle that had died in the fields, when fed to rabbits or injected into the tissues caused death within a few days. A pure culture injected into the jugular vein of a calf

1. Twelfth Annual Report Indiana Agricultural Experiment Station.

2. Amr. Inst. Pasteur, 20, (1906), No. 3, pp. 209-224, abstract from Experiment Station Record, Vol. XVIII, No. 1, p. 88.

3. Nebraska Agricultural Experiment Station, Bulletin Nos. 7, 8, 9 and 10, pp. 165-211.

caused death in two days. Later investigators[4] demonstrated the non-infectious character of the Burrill bacillus by feeding cornstalks affected with this disease. Furthermore, a bacterial examination of the organs of cattle that died in the stalk fields showed no single species of bacteria constantly present.

Brimhall[5] found that all outbreaks of so-called cornstalk disease occurring in Minnesota were not this disease but a specific affection caused by a cocco-bacillus, and known as haemorrhagic septicaemia. The clinical symptoms occurring in the latter disease differ in many respects from the former, in that they do not so closely resemble a toxic poisoning and are not as uniformly nervous in character. At the outset of haemorrhagic septicaemia there is usually a high fever, diarrhoeal discharges may occur, blood stained urine is sometimes passed, and symptoms of a severe congestion and inflammation of the lungs may be manifested. The postmortum lesions are often marked, as would be expected in a disease of this character.

Mayo[6] describes two outbreaks of poisoning in cattle resulting from feeding on corn fodder containing a large quantity of nitrate of potassium. Beneath the leaf sheaf which surrounded the stalk the nitrate had crystalized in fine white crystals that resembled a white mold. A chemical analysis of samples of stalks from the fields where the poisoning occurred showed 18.8 per cent of potassium nitrate. The occurrence of nitrate in perceptible quantities in cornstalks is, without doubt, very rare, as none of the later investigators have reported crystals in any form as present beneath the leaf sheath or in the stalk.

After a careful study of cornstalk disease, Moore[7] stated that the accumulated data indicated a disease of a toxic nature. The character of the poison was not determined but it appeared to be restricted to the corn plant. He considered the observations made by Mayo of much importance, as the finding of poison in cornstalks grown under certain conditions might afford a key to the cause of the disease.

During the summer of 1901 Peters[8] investigated a number of deaths among cattle that resulted from feeding on growing sorghum. In most fields where loss was reported the sorghum appeared stunted. Samples of leaves and stalks were collected and in a watery extract

4. Kansas Agricultural Experiment Station, Bulletin No. 58, Bulletin No. 16, Bureau of Animal Industry.
5. Report of Minnesota State Board of Health, 1900–1903.
6. Kansas Agricultural Experiment Station, Bulletin No. 49.
7. Bulletin No. 10, Bureau of Animal Industry.
8. Nebraska Agricultural Experiment Station, Bulletin No. 52.

from these samples prussic acid was found. Slade estimated that seven or eight pounds of the fodder contained sufficient poison to kill one animal.

Because of the close resemblance between toxic poisoning from sorghum and the symptoms of cornstalk disease, Price[9] deemed it advisable to examine cornstalks for the substances which produce prussic acid in plants. Samples of stalks from fields in which cattle had died were obtained. In these samples he discovered an enzyme which had the property of decomposing a glucoside (amygdalin) and thereby producing prussic acid. However, no glucoside capable of forming this poison as a result of enzyme action was found. The results were not regarded as conclusive, as only a few samples were examined, and the failure to discover a suitable glucoside did not prove its absence in the corn plant, or in other plants in the field.

In an outbreak that occurred a few years ago the possible influence of certain conditions of growth and development of corn in causing the disease was noted. In a neighborhood where the disease was prevalent in its most fatal form twenty-two head of cattle were pastured in a fifteen-acre stalk field for three weeks. They were then turned into an adjoining forty-acre field. Toward the end of the first week three head of stock cattle died. The herd was then taken out of the stalk field and no further loss occurred. The only apparent difference in the two fields was that the forty acres of corn were badly injured by drought during the growing season, and the fifteen acres, which were planted late, yielded a full crop.

Conclusion.

The name cornstalk disease is meaningless, so far as the specific cause of the disease is concerned. In the use of this term we designate the condition under which the sickness and deaths occur. There are, apparently, grouped under this one head several diseases which occur under definite conditions and present a rather uniform line of symptoms. The symptoms closely resemble certain forms of toxic poisoning, but only one investigator reports the finding of a poisonous substance (potassium nitrate). Hence, it is very doubtful if this nitrate is a frequent cause of loss among animals pasturing on cornstalks.

The possibility of the presence in cornstalks of such substances as produce prussic acid is suggested because of the resemblance that the

9. Twenty-First Annual Report. Bureau of Animal Industry. Enzymes in Corn Stalks.

symptoms, and sometimes the conditions under which the disease occurs, has to sorghum poisoning. A reasonable explanation for the failure of investigators to find a toxic substance is that all cornstalks, or portions of the corn plant, do not contain the poison. In a feeding test with spoiled ear corn the failure to produce the same disease as occurs in the field may be due to the different conditions. Animals in the field are able to select their feed. Judging from the small percentage of the herd that is usually affected at any one time, all of the stalks, leaves, and undeveloped and spoiled corn are not injurious, for if the injurious substance was present in all of the food a larger number of the animals in the herd would suffer and the cases would not be distributed over a period of several days, or several weeks.

PURDUE UNIVERSITY

Agricultural Experiment Station

CIRCULAR No. 4

LaFayette, Ind., January, 1907

THE EXPERIMENT STATION BUILDING

By Arthur Goss

As the present Legislature will be asked to make an appropriation for a building to accommodate the work of the State Agricultural Experiment Station, a few words concerning the condition of the present building and the necessity for a new one may not be out of place.

The original building, which was not erected or designed for Station use, consisted of a cheaply constructed two-story brick structure, containing some eight or ten small rooms hardly so large as the rooms of an ordinary dwelling house. Attached to this, was a one story wing which was used for storage purposes. When the State Experiment Station work was brought to Purdue after the passage of the Hatch act in 1887, the first addition, which now forms the central portion of the structure, was made to the original building. A few years later what is now the west wing was added. Some time after this, a wooden second story was added to the brick wing of the original building. In addition to the above, several other extensions in the way of a potting house, greenhouses, etc., have been added from time to time until the building, as it stands at present, is a very badly patched up affair.

The original building, and the various additions to the same, were erected when funds were very scarce and most urgently needed for other purposes, and the present poorly constructed, patched up building is all that it was possible to furnish under the circumstances. No blame is, therefore, to be attached to the management of the University for the present state of affairs, and neither is the State responsible, as it has never heretofore been asked for an appropriation for a Station building.

In the case of the original building, and all the various additions to the same, the object was necessarily to secure the largest possible amount of room at the least possible expense. This resulted in such cheap, flimsy construction that the building soon settled and cracked to an alarming extent. In a number of places the walls are several inches out of plumb and apparently ready to fall down. Within a few years after it was erected the entire front central part of the building broke away from the remaining portion and would undoubtedly have collapsed had the walls not been temporarily tied together with rods. This was not done however, until cracks had appeared in the brick walls through which one's hand could be inserted. See Fig. 5, page 10.

While the rods temporarily prevented the collapse of the building, they did not stop the settling, which is still going on, as is shown by the fact that the paper which was put on a number of rooms about a year ago is torn in the corners as if the walls had been moved up and down on each other. Note the photographic reproduction in Fig. 3, page 8.

The badly distorted condition of the building is also shown by the door frames. Many of these have settled to such an extent that the upright and cross pieces are several inches out of plumb, and the doors can no longer be closed. Fig. 4, page 9, gives an idea of the condition of many of the doors.

The badly racked condition of the building is also shown by the floors. These in many places have settled until they are very badly out of level, as shown in Fig. 1, page 3.

About ten years ago, the building as a whole was condemned as unsafe by a firm of Indianapolis architects, and chained off

from use. After it had been temporarily tied together with rods as indicated above, it was again occupied, as there was no other place available for carrying on the work. The rodding of the building, however, was only considered a temporary expedient, as it was found to be impossible to make repairs that would be of a permanent character. Considering the rapid manner in which the building is settling at the present time, it is believed that the limit of safety has about been reached.



FIG. 1. Condition of floors in many parts of building.
The piece of 2x4 in front of door is level.

The following statements are from the Indianapolis architects, who condemned the building ten years ago, and from one of the members of a firm of contractors and builders of LaFayette who has personally done repair work in the Station building several times within the last year or so, and is therefore in a position to know of the condition of the building. Other similar statements could doubtless be secured, but with the illustrations given, this would seem to be quite unnecessary. If any one has any further doubt concerning the condition of the building he is invited to make a personal inspection, which will certainly be amply convincing.

Indianapolis, Jan. 3, 1907.

To whom it may concern:—

This is to certify that about ten years ago we made an examination of the Agricultural Experiment Station building at Purdue University, LaFayette, Indiana, and found the same to be in an unsafe condition. On our recommendations the building was strengthened and temporary improvements made to make its use available for the time being. We do not believe that it would be possible to repair the building so that it could be made to be safe for much longer, and would advise its abandonment forever. Very respectfully,

R. P. Daggert & Co.,
Architects.

LaFayette, Ind., Jan. 9, 1907.

To whom it may concern:—

This is to certify that after having worked in the Agricultural Experiment Station building at Purdue University several times recently, and having made a careful examination of the same, I find that the building is settling at a rapid rate at the present time, and that some of the walls are badly out of plumb. I do not consider the building in a safe conditon.

I do not believe that it would be possible to repair this building so that it could be put in a satisfactory condition, and would advise its abandonment. Very respectfully,

W. H. Jones.
Of the firm of Strate & Jones, Contractors, LaFayette, Indiana.

Besides being ready to fall down, the present building is utterly unsuited to the work it has to accommodate, both on account of being too small, and of being cut up into small rooms entirely unsuited to laboratory purposes. The view shown in Fig. 2, page 5,was taken in one of the "laboratories" of the Chemical Department. This room has to accommodate a work desk, the apparatus for the determination of nitrogen, the muffle furnaces, the system of burettes for titration work and various other pieces of apparatus. This laboratory is just 7 feet 6 by 11 feet 10 in size. Further comment is quite unnecessary, but it must not be

forgotten that the men working in the Department are compelled to breathe the concentrated mixture of fumes that are generated in, and which cannot be removed from this small space. Various plans have been tried for ventilating the laboratories of the Chemical Department, but owing to their small size and to the fact that no provision for ventilation was made originally, it seems to be a practical impossibility at the present time. It is not a reasonable proposition to require men to work under such conditions, but relief seems impossible until larger, properly ventilated rooms are available.

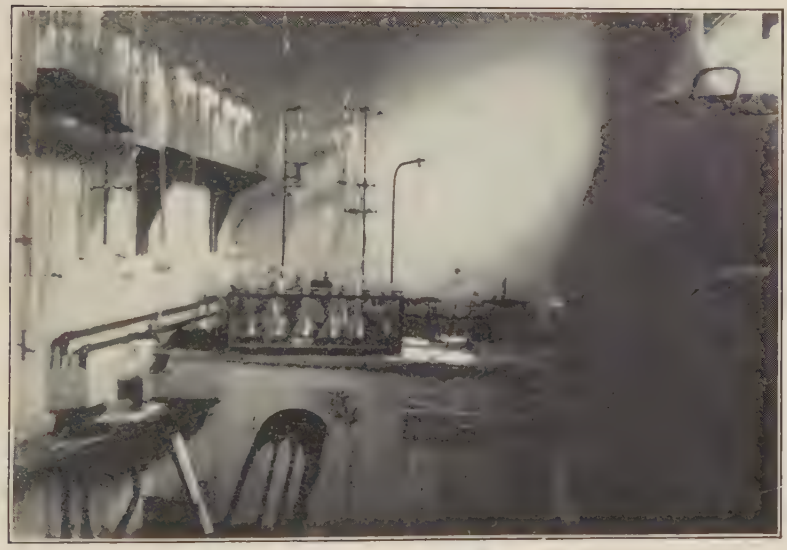


FIG. 2. View in crowded laboratory.
This room is less than 8x12 feet in size. See description above.

There is another similar "laboratory," so called out of respect for the work rather than from the size of the room, just across the hall in which are located among other things, the water baths and drying ovens used in the Fertilizer Control work, the boiler used for the preparation of distilled water, and the battery of ether-extraction apparatus used in the determination of fat in feeding stuffs. When this room is filled with ether vapor

from extraction apparatus at the same time the fire is going under the boiler, which is often necessarily the case, it makes a combination far more combustible than safe.

In brief, the Chemical Department of the Station is crowded throughout to such an extent that the work is very seriously interfered with. The quarters are not suitable either in size or design. At least two or three times as much room should be available for the work of this department at the present time, not to mention future expansion.

Other departments of the Station, such as the Library, are also badly crowded and it has been necessary to temporarily transfer several of the Station workers in the Agricultural and other departments, to the other buildings on account of lack of room in the Station building.

With the present unsafe, inadequate, poorly constructed building as a limiting factor in the calculation, it is impossible to figure out permanent plans. This fact has been pointed out for a number of years past, and applies with much more force now than formerly, as owing to the recent State and Adams appropriations and other changes, the business of the Station has increased four or five fold in the last two or three years, and a building that was inadequate before that time can scarcely be expected to meet the requirements at present.

When a new building is erected, it should be substantially constructed and designed to last. It should be of sufficient size to accommodate the work at present, and allow for a reasonable expansion, which is sure to come in the near future. In this connection may be mentioned the fact that at the last session of the United States Congress the Adams act was passed which will ultimately increase the income of the Station $15,000 annually. This necessarily means an expansion in the work of the Station in the near future, with the probable addition of new departments. New quarters must be provided for this expansion, and under the terms of the Adams act, the same cannot be provided by this fund. They are supposed to be provided by the state which receives the benefit of the appropriation. Then again, the various farmers' organizations of the state are asking the Legislature

to pass a much needed Stock Food Control law, such as the other leading states have. If this is done, and there is every reason why it should be, the Station will doubtless be called upon to administer this work. This will, of course, necessitate additional quarters. Several other matters might also be mentioned, but the above are perhaps sufficient.

A suitable building to meet the requirements at present and allow for the expansion of the work already practically assured, would cost at least $100,000, and a considerably larger amount could be used to good advantage. It is not believed that the erection of a building to cost less than the above amount would be justified from any point of view, and rather than put up a cheaper and an unsatisfactory building, all the Station workers would even prefer to struggle along under the present unsafe and extremely unsatisfactory conditions. It is not believed, however, that the people of a state so wealthy and prosperous as our own, will longer ask the workers in one of its important public institutions to occupy such a miserable structure. The present building is a disgrace to the state, and so far as known, its equal is not to be found in any other state or territory of the Union.



FIG. 3 Break in wall paper put on a year ago, showing that building is settling rapidly. This condition is found in all rooms that have been papered.

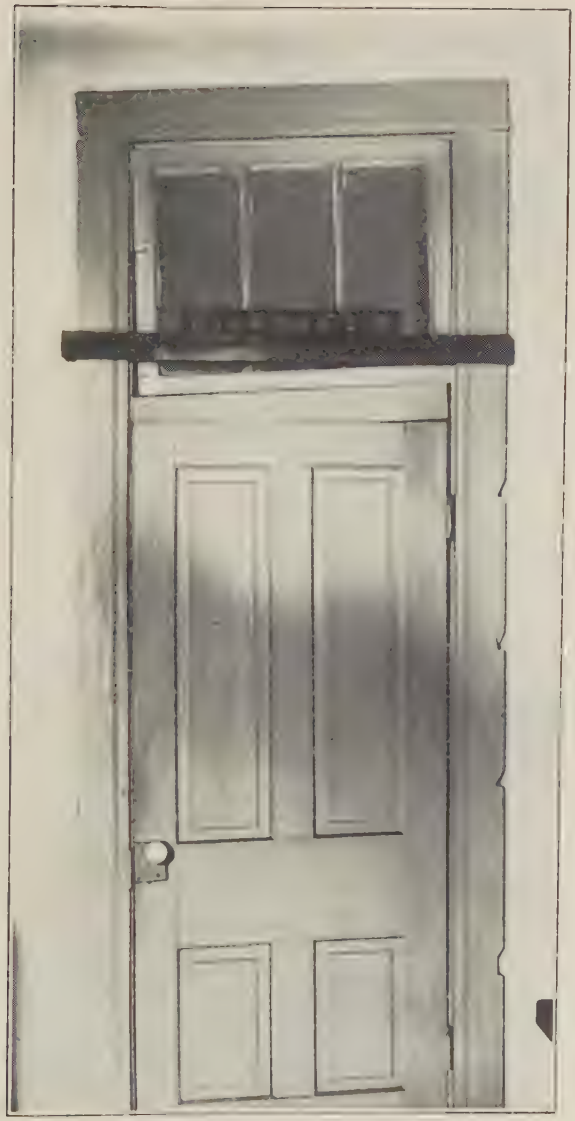


FIG. 4. Distorted condition of door, due to settling of building.
The board across the transom is level.
Many doors in building are in a similar condition.



FIG 5. Crack in corner where central portion has pulled away from original building. See description, page 2.

PURDUE UNIVERSITY

Agricultural Experiment Station

CIRCULAR No. 5.

LaFayette, Ind., December, 1906.

REPORT OF EXPERIMENTAL WORK ON THE RANDOLPH COUNTY FARM, 1906.

By G. I. Christie.

At the annual meeting of the Randolph County Farmers' Institute, January, 1906, the subject of "County Farm Experiment Stations" was discussed by G. I. Christie of Purdue University Agricultural Experiment Station. Much interest in this scheme was manifested by the farmers present and steps were at once taken to establish some experimental work on the Randolph County Farm. A committee composed of E. W. Hill, I. C. Reynard, W. P. Nofsinger, G. E. Addington and I. J. Farquhar was appointed to arrange for the carrying on of this work.

Objects of County Experiment Stations.

In every county there is much information to be obtained with reference to the treatment of certain types of soil, varieties of corn, grains, grasses and vegetables. The average farmer cannot afford the time or expense to test hundreds of varieties of corn, small grains, etc. that seem to have merit in them. Neither has he the time to study new methods of cultivation that might be suited to his locality. Such a procedure is next to impossible.

It is generally felt that the State Experiment Station is doing a splendid work for the State, yet much of the data obtained at the Station in regard to crops is necessarily local in its application to farmers' conditions. Farmers on high priced land have for some time realized this, and are demanding results that are applicable to local conditions in their county or section of the State. For such work, what better place could be devised than the County Farm?

By using a part, if not all of the land on the County Farms of the State for local experimental work, it is possible for the State Station to direct a line of experiments that should mean much to every farmer, and while the expense of these experiments would be but a few cents to each farmer, the results would mean hundreds of dollars to them.

Corn Variety Test.

In response to a call issued by the committee in charge of the County Farm Work, twenty-three farmers of Randolph County furnished a small quantity of corn similar to that planted on their own farms for the experiment on the County Farm at Winchester. In the presence of about twenty-five farmers and G. I. Christie of Purdue Experiment Station, this corn was planted on May 17th. Each variety was tested in the planter and the plates adjusted before planting. The seed was then drilled in two rows about 50 rods long. The rows were 3½ feet apart and the aim was to have the stalks 16 inches apart in the row.

A variety of corn furnished by D. B. Densmore was planted at intervals across the plot to serve as a check on any variations there might be in the fertility of the soil. The results at harvest time showed the plot, in this particular, to be a most uniform piece of ground. The ground used for the experiment was black bottom soil, medium in fertility.

The corn was harvested November 3rd, and the following table shows the results obtained:—

Plot No.	Contributor	Variety	% of stand	% of bar'n stalks	Yield bu. pr acre	Date of Maturity
1	Boone County	Boone Co. White	79	6.9	90.3	Oct. 5
2	J. H. Robinson	Leaming	92	7.7	84.3	Sept. 10
3	Sol. Mosier	Yellow	63.6	13.9	64.3	" 15
4	Dave Lasley	"	68.8	10.3	64.3	" 15
5	J. E. Lasley	"	69.2	8.8	64.6	" 15
7	D. W. Wilmore	"	68.1	11.7	68.6	" 15
8	S. I. Starbuck	"	67.6	11.2	68.6	" 15
9	E. M. Johnson	"	71.1	7.6	64.8	" 15
10	I. C. Reynard	"	76.4	8.7	75.7	" 15
11	D. B. Densmore	"	74.2	9.3	68.8	" 15
12	W. P. Nofsinger	"	83.3	4.8	76.3	" 15
13	L. D. Lantern	Lantern's Yellow	72.1	6.	70.	" 15
14	Elza Reynard	Mixed	74.9	5.	65.7	" 15
15	Worth Osborn	Golden Dent	72.1	4.2	72.8	" 22
16	Heston Bros.	Yellow	65.3	4.9	67.1	" 15
17	Jas. Hammond	Golden Leaming	79.1	5.7	75.7	" 22
18	R. L. Bushman	Mixed	78.8	3.2	68.6	" 15
19	W. S. Gordon	Yellow	84.6	7.	62.8	" 15
20	T. P. Miller	"	78.5	5.5	72.8	" 15
21	S. A. Botkin	"	77.2	7.2	71.4	" 15
22	Dr. O. E. Able	"	78.4	7.	47.1	Aug. 25
23	Joel Coates	"	83.1	5.2	68.6	Sept. 15
24	J. F. Michael	"	79.9	8.9	70.	" 15
25	Willard Lasley	"	85.9	8.8	68.6	" 15
26	Champ'gn Co. Ill.	Leaming	83.8	7.4	78.6	Sept. 30
27	Tippecanoe Co.	Reid's Y. Dent	86.3	8.3	71.4	" 30
28	Johnson Co.	Pride of Ind.	72.6	9.8	72.8	Oct. 5

The above figures show that most of the varieties produced over sixty bushels of corn to the acre. This may be accounted for by the fact that most of these varieties were supplied by some of the best farmers in Randolph County.

In studying the table, it is noticed that the yield of variety 1 and 22 varies from 90.3 bushels per acre to 47.1 bushels per acre. In a further study it is noticed that the stand and per cent of barren stalks of these two varieties are practically the same, This allows us at once to draw the conclusion, since the soil and other conditions were the same, that the difference was in the "*producing power*" of these two varieties of corn. This difference in the producing power may have been due to the difference in vitality of the seed planted,

or the care in the selection and breeding of the varieties. Let this be as it may, the difference is there in a marked degree, and corn growers can afford to give their most careful attention to this point.

It is only fair to state that variety No. 1 was imported from Boone County, Indiana, and at time of harvesting was not well matured and contained a high per cent of moisture, in this way giving a little higher yield than it otherwise would. However, allowing this, still the difference in yield is very marked.

Other varieties as No. 2, 10, 12, 13, 15, 17, emphasize the same point only in a less marked degree.

Since the results are from but one year's work, no definite conclusions can be drawn, but the work does give sufficient data to allow us to form the opinion:

1. That the farmers of Randolph County possess some valuable strains or varieties of corn for their locality.

2. That imported varieties did not prove as satisfactory as home grown varieties.

3. That there are farmers in Randolph County who are growing strains or varieties of corn which have not the highest producing power and who would be benefited by giving attention to this point.

ACKNOWLEDGEMENTS.

The success of this experiment was due in a large measure to the careful supervision of Superintendent Harry Hull, and the untiring efforts of the committee in charge of the work.

PURDUE UNIVERSITY

Agricultural Experiment Station

CIRCULAR No. 6.

LaFayette, Ind., April, 1907.

THE FEEDING STUFF CONTROL LAW.

By Arthur Goss and W. J. Jones, Jr.

The following circular is prepared for the purpose of furnishing information concerning the law regulating the sale and inspection of concentrated commercial feeding stuffs in Indiana as passed by the recent Legislature, and which is now in force. This circular contains the full text of the law, method of administering the same and working regulations of the State Chemist's office as related to the sale of concentrated commercial feeding stuffs.

Indiana Feeding Stuff Law.

Section 1. Be it enacted by the General Assembly of the State of Indiana, That before any concentrated commercial feeding stuff is sold, offered or exposed for sale in Indiana, the manufacturer, importer, dealer, agent or person who causes it to be sold, or offered for sale, by sample, or otherwise, within this State, shall file with the State Chemist of Indiana at the Indiana Agricultural Experiment Station, Purdue University, a statement that he desires to offer such concentrated commercial feeding stuff for sale in this State, and also a certificate, the execution

of which shall be sworn to before a notary public, or other proper official, for registration, stating the name of the manufacturer, the location of the principal office of the manufacturer, the name, brand or trade-mark under which the concentrated commercial feeding stuff will be sold, the ingredients from which the concentrated commercial feeding stuff is compounded, and the minimum percentage of crude fat and crude protein allowing one per cent. of nitrogen to equal six and twenty-five hundredths per cent. of protein, and the maximum percentage of crude fibre which the manufacturer, or person offering the concentrated commercial feeding stuff for sale guarantees it to contain; these constituents to be determined by the methods recommended by the association of official agricultural chemists of the United States.

Sec. 2. Any person, company, corporation or agent that shall sell or offer, or expose for sale, any concentrated commercial feeding stuff in this State, shall affix, or cause to be affixed to every package or sample of such concentrated commercial feeding stuff in a conspicuous place on the outside thereof, a tag or label which shall be accepted as a guarantee of the manufacturer, importer, dealer or agent, and which shall have plainly printed thereon in the English language, the number of net pounds of concentrated commercial feeding stuff in the package, the name, brand, or trade-mark under which the concentrated commercial feeding stuff is sold, the name of the manufacturer, the location of the principal office of the manufacturer, and the guaranteed analysis stating the minimum percentage of crude fat and crude protein, determined as described in section 1, and the ingredients from which the concentrated commercial feeding stuff is compounded. For each one hundred pounds, or fraction thereof, the person, company, corporation or agent, shall also affix a stamp purchased from the State Chemist, showing that the concentrated commercial feeding stuff has been registered as required by section 1 of this act, and that the inspection tax has been paid. When concentrated commercial feeding stuff is sold in bulk a tag as hereinbefore described, and a State Chemist stamp shall be delivered to the consumer with each one hundred pounds, or fraction thereof;

Provided, That for wheat bran a special stamp covering fifty pounds shall be issued on request, and one such stamp, attached to the tag hereinbefore mentioned, shall be delivered to the purchaser with each fifty pounds or fraction thereof.

Sec. 3. The State Chemist shall register the facts set forth in the certificate required by section 1 of this act in a permanent record, and shall furnish stamps or labels showing the registration of such certificate to manufacturers or agents desiring to sell the concentrated commercial feeding stuff so registered at such times and in such numbers as the manufacturers or agents may desire: Provided, That the State Chemist shall not be required to sell stamps or labels in less amount than to the value of five dollars ($5.00) or multiples of five dollars for any one concentrated commercial feeding stuff: Provided, further, That the State Chemist shall not be required to register any certificate unless accompanied by an order and fees for stamps or labels to the value of five dollars ($5.00) or some multiple of five dollars: Provided, further, That such stamps or labels shall be printed in such form as the State Chemist may prescribe: Provided, further, That such stamps or labels shall be good until used.

Sec. 4. On or before January 31st of each year, each and every manufacturer, importer, dealer, agent or person, who causes any concentrated commercial feeding stuff to be sold or offered or exposed for sale in the State of Indiana shall file with the State Chemist of Indiana a sworn statement, giving the number of net pounds of each brand of concentrated commercial feeding stuff he has sold or caused to be offered for sale in the State for the previous year ending with December 31st: Provided, That when the manufacturer, jobber or importer of any concentrated commercial feeding stuff shall have filed the statement aforesaid, any person acting as agent for said manufacturer, importer or jobber, shall not be required to file such statement.

Sec. 5. For the expense incurred in registering, inspecting and analyzing concentrated commercial feeding stuffs, the State Chemist shall receive for stamps or labels furnished, one dollar per hundred: Provided, That for wheat bran a special stamp as required by section 2 of this act shall be furnished at fifty cents

per hundred. The money for said stamps, or labels, shall be forwarded to the said State Chemist, who shall pay all such fees received by him to the director of the Indiana Agricultural Experiment Station, Purdue University, by whom they shall be paid into the treasury of said Indiana Agricultural Experiment Station, the Board of Control of which shall expend the same, on proper vouchers to be filed with the Auditor of State in meeting all necessary expenses in carrying out the provisions of this act, including the employment of inspectors, chemists, expenses in procuring samples, printing bulletins giving the results of the work of feeding stuff inspection, as provided for by this act, and for any other expenses of said Indiana Agricultural Experiment Station as authorized by law. The Director of said Experiment Station shall make to the Governor, on or before February 15th of each year, a classified report showing the total receipts and expenditures of all fees received under the provisions of this act.

Sec. 6. Any person, company, corporation or agent that shall offer for sale, sell or expose for sale any package or sample or any quantity of any concentrated commercial feeding stuff which has not been registered with the State Chemist as required by section 1 of this act, or which does not have affixed to it the tag and stamp required by section 2 of this act, or which is found by an analysis made by or under the direction of the State Chemist to contain a smaller percentage of crude fat or crude protein than the minimum guarantee, or which shall be labeled with a false or inaccurate guarantee, or who shall adulterate any concentrated commercial feeding stuff with foreign mineral matter or other foreign substance, such as rice hulls, chaff, mill sweepings, peanut shells, corn bran, corn cob meal, oat hulls, oat clippings, or other materials of less or of little or no feeding value without plainly stating on the label hereinbefore described, the kind and amount of such mixture, or who shall adulterate with any substance injurious to the health of domestic animals, or who shall alter the stamp, tag or label of the State Chemist, or shall use the name and title of the State Chemist on a stamp, tag or label not furnished by the State Chemist, or shall use the stamp, tag or label of the State Chemist the second time, or shall refuse or

fail to make the sworn statement required by section 4 of this act, shall be deemed guilty of a misdemeanor, and on conviction thereof shall be fined in the sum of fifty dollars for the first offense, and in the sum of one hundred dollars for each subsequent offense. In all litigation arising from the purchase or sale of any concentrated commercial feeding stuff in which the composition of the same may be involved a certified copy of the official analysis signed by the State Chemist shall be accepted as prima facie evidence of the composition of such concentrated commercial feeding stuff: Provided, That nothing in this act shall be construed to restrict or prohibit the sale of concentrated commercial feeding stuff in bulk to each other by importers, manufacturers or manipulators who mix concentrated commercial feeding stuff for sale, or as preventing the free, unrestricted shipment of these articles in bulk to manufacturers or manipulators who mix concentrated commercial feeding stuff for sale, or to prevent the State Chemist, or the Indiana Agricultural Experiment Station, or any person or persons deputized by said State Chemist, making experiments with concentrated commercial feeding stuffs for the advancement of the science of agriculture.

Sec. 7. The State Chemist or any person by him deputized is hereby empowered to procure from any lot, parcel or package of any concentrated commercial feeding stuff offered for sale or found in Indiana a quantity of concentrated commercial feeding stuff not to exceed two pounds: Provided, That such sample shall be drawn during reasonable business hours, or in the presence of the owner of the concentrated commercial feeding stuff or of some person claiming to represent the owner.

Sec. 8. Any person who shall prevent or strive to prevent the State Chemist, or any person deputized by the State Chemist, from inspecting and obtaining samples of concentrated commercial feeding stuff, as provided for in this act, shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be fined in the sum of fifty dollars for the first offense, and in the sum of one hundred dollars for each subsequent offense.

Sec. 9. The State Chemist is hereby empowered to prescribe and enforce such rules and regulations relating to concentrated commercial feeding stuff as he may deem necessary to carry

into effect the full intent and meaning of this act, and to refuse the registration of any feeding stuff under a name which would be misleading as to the materials of which it is made, or when the percentage of crude fiber is above or the percentage of crude fat or crude protein below the standards adopted for concentrated commercial feeding stuffs. The State Chemist is further empowered to refuse to issue stamps or labels to any manufacturer, importer, dealer, agent or person who shall sell or offer or expose for sale any concentrated commercial feeding stuff in this State and refuse to submit the sworn statement required by section 4 of this act.

Sec. 10. It shall be the duty of every prosecuting attorney to whom the State Chemist shall report any violation of this act to cause proceedings to be commenced against the person or persons so violating the act, and the same prosecuted in the manner required by law.

Sec. 11. The term "concentrated commercial feeding stuff" as used in this act, shall include linseed meals, cocoanut meals, gluten feeds, gluten meals, germ feeds, corn feeds, maize feeds, dairy feeds, starch feeds, sugar feeds, dried brewers' grains, malt sprouts, dried distillers' grains, dried beet refuse, hominy feeds, cerealine feeds, rice meals, rice bran, rice polish, peanut meals, oat feeds, corn and oat feeds, corn bran, wheat bran, wheat middlings, wheat shorts and other mill by-products not excluded in this section, ground beef or fish scraps, dried blood, blood meals, bone meals, tankage, meat meals, slaughter house waste products, mixed feeds, clover meals, alfalfa meals and feeds, peavine meal, cotton seed meal, velvet bean meal, sucrene, mixed feeds and mixed meals made from seeds or grains, and all materials of similar nature used for food for domestic animals, condimental feeds, poultry feeds, stock feeds, patented proprietary or trade and market stock and poultry feeds; but it shall not include straw, whole seeds, unmixed meals made directly from the entire grains of wheat, rye, barley, oats, Indian corn, buckwheat and broom corn, nor wheat flours or other flours.

Sec. 12. All laws and parts of laws in conflict with this act are hereby repealed.

How Law Will Be Administered.

The Feeding Stuff law is under the same organization and is quite similar to the State Fertilizer law and will be administered in much the same way. Inspection samples will be drawn in the open market by deputies sent out by the State Chemist. These samples will be forwarded to the State Chemist's laboratory at the Agricultural Experiment Station, LaFayette, and analyzed. The results of the analysis of the inspection samples, together with the guaranteed composition of the same, will be published in bulletin form.

How to Comply With the Law.

1. *Statement.*—Before offering any concentrated commercial feeding stuff for sale in the State, a statement must be filed with the State Chemist at the Agricultural Experiment Station, LaFayette, Ind., setting forth the fact that it is desired to offer such concentrated commercial feeding stuff for sale. One statement may be made to cover all brands registered at the same time.

2. *Certificate.*—The above statement must be accompanied by a certificate for each brand, the execution of which has been acknowledged before a notary or other proper official, giving the name of the person desiring to register the concentrated commercial feeding stuff for sale, the location of his principal office, the name under which the concentrated commercial feeding stuff will be offered for sale, the ingredients from which it is compounded and the minimum percentage of crude fat and crude protein and the maximum percentage of crude fibre which the feeding stuff is guaranteed to contain.

Certificates are not to be filed annually but once for all, and care should be taken that they are correct in every particular before being filed. The composition of a registered brand cannot be changed without changing the name of the brand.

3. *Guarantee.*—The guaranteed percentage of crude fat, crude protein and crude fibre should be made only to the first decimal place; thus, 25.2 per cent. and not 25.25 per cent. This

rule will be following in printing the guarantee on the tags and labels and where guarantees are given beyond the first decimal place the figures so furnished will be dropped.

4. *Tags and Labels.*—A tag or label furnished by the State Chemist must be attached to each package of concentrated commercial feeding stuff for each 100 pounds or fraction thereof contained therein. The tag or label must show the official number of the brand, the number of net pounds in the package, the name of the person registering the material, the name of the brand, the minimum guarantee of crude fat and crude protein and the ingredients from which the concentrated commercial feeding stuff is compounded.

For material sold in bags, buckets or bulk, a manila tag will be furnished and for material sold in packages a gummed label will be furnished. These tags or labels will have printed thereon the statement required by section 2 of the law, and will be stamped with the fac simile signature of the State Chemist, showing that the brand so labeled has been properly registered and the inspection tax paid.

No tag or label will be issued for more than 100 pounds net, but any number of pounds from one to 100 will be printed on the tag or label to meet the wishes of the manufacturer. If it is desired to sell in packages of more than 100 pounds, a tag or label must be attached for each 100 pounds and fraction thereof. Thus if it is desired to sell in 125 pound bags a tag showing 100 pounds net and a second tag showing 25 pounds net must be attached to each bag. For a 200 pound bag two tags, each showing 100 pounds net, must be attached.

Tags and labels will also be furnished with the number of net pounds left blank and the manufacturer may stamp in the required amount. When this is done it should be noted that not over 100 pounds can be legally used on a tag or label.

5. *How to Order Tags and Labels and Cost of Same.*—Tags or labels will be furnished only in lots to the value of $5.00 or some multiple thereof. Each certificate must be accompanied by an order for at least $5.00 worth of tags or labels before it will be registered.

Tags and labels covering packages containing from one to 100 pounds net will be issued at a cost of one cent each. For *wheat bran* a special tag or label covering from one to 50 pounds will be issued for one-half cent each. When the special tag or label for wheat bran is desired the fact must be stated. It must also be stated in ordering for any brand whether tags or labels are desired. *Remittance* must always accompany orders.

For the convenience of manufacturers, any order may be divided into tags and labels to meet their needs, but no $5.00 order may be divided into more than two classes. Thus an order for tags or labels may be divided into tags or labels for 100 pounds net and 25 pounds net or any other division desired. When an order is divided into tags *and* labels, however, no further division may be made.

Tags or labels for registered brands may be ordered at any time by the person registering the same in lots to the value of $5.00 or some multiple of $5.00. Tags and labels are good until used.

6. *Sales in Bulk.*—When concentrated commercial feeding stuff is sold in bulk either in car load lots or in pound lots from bags, barrels or other original packages, a tag or label must be delivered to the purchaser with each 100 pounds or fraction thereof.

7. *Statement of Sales.*—On or before January 31 of each year, each person registering concentrated commercial feeding stuff for sale in Indiana is required to file with the State Chemist a sworn statement showing the number of net pounds of each brand of concentrated commercial feeding stuff he has sold or caused to be offered for sale in Indiana during the previous year ending December 31.

8. *Only Inspection Samples Analyzed.*—Manufacturers or persons desiring to register concentrated commercial feeding stuff for sale are not required to send samples to the State Chemist for analysis. The only samples which will be analyzed will be those taken by the State Chemist's deputies from brands offered for sale in the open market.

9. *Feeding Stuffs Not Included in the Law.*—Hay, straw, whole seeds, unmixed meals made directly from the entire grains of wheat, rye, barley, oats, Indian corn, buckwheat and broom corn, wheat flours and other flours are exempt from registration under the law. Corn and cob meal may also be sold without registration.

10. *Blank Forms Furnished.*—Blank forms for registering brands as required by section 2 of the law and any further information desired relating to the sale and inspection of concentrated commercial feeding stuffs will be furnished on request.

11. *Indiana millers* who desire to register by-products for sale, and who are unable to furnish guarantees, are requested to communicate with the State Chemist.

12. *All communications* relating to the sale of concentrated commercial feeding stuffs should be addressed to the State Chemist, Indiana Agricultural Experiment Station, LaFayette, Ind.

PURDUE UNIVERSITY

Agricultural Experiment Station

CIRCULAR No. 7.

LaFayette, Ind., April, 1907.

Additional Information Concerning the Feeding Stuff Control Law

By Arthur Goss and W. J. Jones, Jr.

The following circular has been prepared in answer to the numerous requests for additional information concerning the new Indiana Feeding Stuff Control Law, which went into effect April 10. This circular is supplemental to Circular No. 6, of the Agricultural Experiment Station, which contains a full text of the law and comments on the administration of the same.

How the Law Came to be Enacted.

A number of persons have asked how the present law came to be enacted, and why such a measure was necessary. In answer to this it may be said that it was passed in compliance with the demands of the farmers and feeders of the state for protection against the large amount of inferior and adulterated feeding stuff known to be sold on the Indiana market. Resolutions calling for the passage of such a law have been passed by nearly all the agricultural organizations of the state at different times during several years past. The State Live Stock Association, the State Dairy Association, and the State Corn Grower's Association, passed such resolutions a short time before the meeting of the last Legislature, and took active steps to secure the passage of the present law.

As most of the leading states, including all our neighbors, have feeding stuff control laws, it was realized by the feeders of

the state that Indiana was serving as the dumping ground for fraudulent and adulterated feeding stuffs that could not be marketed elsewhere.

That the Indiana market is flooded with adulterated feeding stuffs is a well know fact, which no one conversant with the existig conditions will attempt to deny. Letters are on file in the State Chemist's office from dealers outside of the state in which the statement is made that Indiana is well known to be the home of adulterated feeding stuffs. There is also convincing evidence in this connection on file in the State Chemist's office in the form of analyses of numbers of samples of grossly adulterated feeding stuffs that were on sale in the state.

In view of the above state of affairs some law regulating the sale of feeding stuffs in this state was imperative and inevitable.

The present law was formulated after a careful study of the laws of all the other states, and is believed to be a fair law and one that will be found to meet the various requirements of such a measure as well as any that could be devised. The laws of some other states are very much more stringent in their provisions than the Indiana law without, affording any material additional protection against adulteration. In some states violations of the feeding stuff laws are made penitentiary offenses.

The present law should not only give the farmers and feeders the protection they demand and have a right to expect, but should also result in placing the traffic in feeding stuffs in the state on a strict business basis by making it possible for every one to know exactly what he is buying and selling. The manufacturer or dealer who is doing a legitimate business should be benefited by the law as he will no longer be compelled to compete with those selling low priced adulterated goods as the genuine article.

The Indiana law was placed on a ton tax basis the same as the laws of a number of other states. In nearly all such cases the tax is the same as required by the Indiana law, namely 20 cents per ton. In one or two cases, the tax is 25 cents per ton, but these are exceptions to the general rule. In no case is the tax less than 20 cents per ton where the inspection business is on the ton tax basis. In some states an anuual tax is levied on each

kind of feeding stuff sold instead of so much per ton. This plan, however, makes the small miller or dealer pay more than his share, and is therefore not believed to be so equitable as the ton tax system.

The administration of the Indiana law was placed in charge of the State Chemist at the Indiana Agricultural Experiment Station in accordance with the wish of the Agricultural Organizations of the state, as that seemed to be the logical place for it, because the fertilizer control law, a very similar measure, has been for many years administered through this office. It may also be added that the feeding stuff control laws of most states are administered at the State Agricultural Experiment Stations the same as is required by the Indiana law.

Disposition of the Funds.

A number of questions have been asked concerning the disposition of the funds derived from the enforcement of the Feeding Stuff Control law. While this seems to be very clearly stated in the law itself, a few words of explanation may perhaps be desirable.

The income from the feeding stuff control will be used first for paying the expenses necessarily incurred in carrying out the provisions of the law. This will include the salaries and traveling expenses of inspectors engaged in collecting samples, reporting cases of violation of the law, etc., the salaries of chemists, who will be employed to analyze the inspection samples, the expenses of printing tags and bulletins, and the cost of the necessary apparatus, chemicals and supplies for carrying on the work. Whatever may be left after paying the expenses mentioned above, will be used for advancing the work of the Experiment Station. As the farmers and feeders of the state will no doubt ultimately have to pay most of the cost, such a disposition of the funds would seem to be entirely logical.

Statement and Certificate.

Before any feeding stuff covered by the law can be legally sold in the state, a statement to the effect that it is desired to sell such feeding stuff, must be filed with the State Chemist together

with a certificate showing the name of the brand to be offered for sale, the name of the manufacturer or agent desiring to sell the same, the materials from which the feeding stuff is compounded, and the guaranteed composition of the brand in question, including the minimum percentage of crude fat and crude protein, and the maximum percentage of crude fiber. One such statement and certificate must be filled out and sworn to before a notary for each brand registered. Brands are not required to be registered annually, once being sufficient so long as the name and guaranteed composition remains the same. If it is desired to change either the name or composition, a new certificate must be filed.

The form of statement and certificate used is shown at the end of this circular, (form 1905). Blank statements and certificates will be furnished on request.

How to Make Guarantee of Composition.

The best and most satisfactory way to make the guarantee of composition that is required by law, is to have an average sample of the material to be sold analyzed by some competent chemist. We would suggest in this connection that persons desiring to have material analyzed, write to Mr. J. C. Hite, ex-President of the Indiana Millers' Association, Peru, Ind., who we are informed has arranged to have such work done at a very reasonable rate.

Those not wishing to go to the expense of having analyses made could probably make guarantees for standard products, such as pure wheat bran and middlings, by using average figures for such materials. In the case of mixed feeds, such as corn and oats feed, the composition might be calculated from the composition of the ingredients contained.

The following figures represent about the average composition of the materials named. In making guarantees in this way, however, we would recommend using figures somewhat lower than the averages, in order to be safe, and in this connection would suggest the figures given below:

Average Composition.

Material.	Per Cent. Crude Fat.	Per Cent. Crude Protein.	Per Cent. Crude Fiber.
Corn (Indiana)	4.3	9.0	2.0
Oats (Indiana)	4.5	12.7	9.6
Corn Bran	5.8	9.0	12.7
Wheat Bran	4.0	15.4	9.0
Wheat Middlings (Ind.)	5.0	15.4	5.0
Wheat Middlings	5.6	17.4	5.2
Wheat Shorts	4.5	14.9	7.4
Wheat Screenings	3.0	12.5	4.9
Rye Bran	2.8	14.7	3.5
Rye Shorts	2.8	18.0	5.1
Buckwheat Bran	3.3	12.4	31.9
Buckwheat Middlings	7.1	28.9	4.1

Composition Suggested for Guarantees.

Corn and Oat Chop, 56 lb. corn, 32 lbs. oats	3.9	9.5	6.0
Corn Bran	5.0	8.0	13.0
Wheat Bran	3.8	14.0	10.0
Wheat Middling	4.0	14.0	7.0
Wheat Shorts	4.0	14.0	8.0
Wheat Screenings	3.0	12.0	6.0
Rye Bran	2.5	14.0	5.0
Rye Shorts	2.5	17.0	6.0
Buckwheat Bran	3.0	12.0	33.0
Buckwheat Middlings	6.9	27.0	5.0

How to Order Tags and Labels.

As soon as the properly executed statement and certificate for any brand of feeding stuff and the necessary fees for the same are received, the tags or labels necessary for complying with the law will be printed and forwarded at once.

The tags and labels furnished are of two kinds, manilla shipping tags, suitable for attaching to sacks, and gummed labels,

suitable for sticking to packages. In ordering, be sure to state whether tags or labels are desired.

It is to be noted that tags or labels must be ordered for each brand in lots of $5.00 worth or some multiple thereof. Tags or labels may be ordered at any time, as needed, and are good until used.

Percentage of Crude Fiber Not Shown on Tag.

While the law requires that both the minimum percentage of crude fat and crude protein and the maximum percentage of crude fiber shall be given in the guarantee, only the percentage of crude fat and crude protein will be printed on the tag. The guarantee covering crude fiber will be used for the purpose of reference and checking up the composition of brands in the State Chemist's laboratory.

Tags Issued for Smaller Amounts Than One Hundred Pounds.

In compliance with numerous requests from dealers for tags covering a smaller amount than one hundred pounds to meet the requirements of the retail trade, it has been decided to issue tags to cover three sizes of packages or weights of feeding stuffs, namely for one hundred pounds or any less amount at one cent each, for fifty pounds or any less amount for one-half cent each, and for twenty-five pounds or any less amount, for one-fourth cent each. While this provision is plainly not required in the law, it is made for the especial accommodation of dealers who sell in small quantities.

Any five dollar order may be divided into the three classes above as desired, or into tags and labels as desired.

Space on Tag For Net Weight of Package Left Blank if Desired.

Unless otherwise specified in ordering, tags and labels will have the net weight of package for which they are good, printed on them, but for the further convenience of retail dealers, *if requested*, the space for the net weight will be left blank to be

filled in by the dealer as required. In all cases, however, the maximum number of pounds for which the tag or label is good, will be printed on it.

The data that appears on the tag or label can be seen by referring to the form on page 13 of this circular.

Mill By-Products Sold and Exchanged.

Mill by-products covered by the law, such as bran and middlings, if exchanged for grain or other produce must be registered and tagged the same as if sold. The following is the ruling of the Attorney-General in this connection:

"In answer to your question, 'Do bran, shorts and other mill products covered by the law, have to be registered and tagged, when delivered to a customer from the common bin in exchange for grain or other products?' It is my opinion that the same requirements are necessary under such circumstances as are necessary in case of a sale."

Delivery in Bulk or Customers' Sacks.

The same number of tags must be delivered to the purchaser in the case of bulk sales of unsacked material as in the case of sacked material. If a customer brings his own sacks, tags covering the amount sold, must be delivered to him.

Special Mixtures.

As all mixed feeds, covered by the law are required to be registered and tagged, and the ingredients from which they are compounded stated, the compounding of special mixtures to order for customers can only be done by registering such mixtures before hand, stating from what they will be compounded, and making the guarantee of composition low enough to cover variations in the amounts of the ingredients put in. The ingredients for any sort of mixture can of course be sold to a customer from properly registered goods, and he can mix them in any proportion he desires.

Condimental and Medicated Stock and Poultry Feeds.

The question has been raised by manufacturers of condimental and medicated stock and poultry feeds, as to whether they come under the Indiana Feeding Stuff law, the claim being made that such preparations are more in the nature of medicines than foods. The ruling of the State Chemist on this point is that when such material is sold under the name, brand or trade mark of stock or poultry, feed or food, it comes under the law, and must be registered and tagged, and the materials from which it is compounded, stated, the same as in the case of non-medicated feeding stuffs. This point has been submitted to Attorney-General Bingham, and the following is his opinion:

"In answer to yours of the 29th ult., in which you ask whether condimental and medicated preparations, such as Pratt's Stock Food, International Stock Food, Dr. Hess' Stock Food, Raleigh's Imperial Stock Food, and others of a similar character, when sold under the name, brand or trade mark of stock or poultry foods, are covered by the act to regulate the sale of concentrated commercial feeding stuffs in the State of Indiana, passed by the last General Assembly, I beg to advise that in my opinion section 11 of the act referred to covers all classes of stock food other than those excluded from its operation by the following express language of said section, to-wit:

"But it shall not include straw, whole seeds, unmixed meals made directly from the entire grains of wheat, rye and barley."

It will be observed that among other things included in the definition of concentrated commercial feeding stuff in said section are "condimental feeds, poultry feeds, stock feeds, patent proprietary or trade and market stock and poultry feeds."

The word "condiment" is defined in the Standard Dictionary of the English language, to be a "sauce, relish, spice or the like, used to season or give relish to food."

The word "proprietary" is defined in the American and English Encyclopedia of Law (2ed.—as follows:

"The word proprietary is defined as belonging to ownership; pertaining to a proprietor; relating to a certain owner or proprietor."

In the case of Ferguson v. Arthur, 117 U. S. 487, the court quotes from Webster's, Worcester's and the Imperial Dictionaries. This case involved the meaning of the term proprietary medicines. In the International Revenue Laws, R. S. U. S., schedule a to paragraph 3419, the court declared that any medicinal preparation might be proprietary without being made by a private formula, or under an exclusive right claimed to the making or preparing it, or under a patent, but by reason alone that it was recommended to the public as a proprietary medicine or as a remedy for disease.

You have also submitted to me what I take to be a wrapper for a package of Pratt's Food for Horses and Cattle, which has printed upon it in large glaring letters, the words, more conspicuous than anything else appearing upon same, "Pratt's Food for Horses and Cattle; Pratt Food Company," and an apparent trade mark "Pratt's Food," gotten up in such form as to make predominant over everything else appearing thereon, the idea that the package covered by same contained some sort of food.

You submit also what I take to be a wrapper for a package of International Stock Food. On this wrapper also appears in glaring letters the words "International Stock Food" in such form as to carry the impression that the package wrapped in same contains some sort of stock food.

You also submit what I take to be one side of the box or package in which Raleigh's Imperial Stock Food is sold. Upon this also appears more conspicuous than anything else the words "Imperial Stock Food" with nothing thereon to indicate that the box of which same was a part contained anything else but stock food.

It is perfectly plain that the manufacturers or dealers referred to are endeavoring to sell this product as a stock food. It is true that upon one of the wrappers referred to, and I refer especially to that of Pratt's Food for Horses and Cattle, the words "A regulator not a feed" appear, though in much finer print than

the words heretofore referred to, and that the printed matter, which is still much finer, explains that no nutritive properties are claimed for Pratt's Food, and that it is a medicinal tonic and regulator. While it is true in my opinion that if such products were properly advertised and sold as a medicine, or as something other than a food, it would remain a question of fact as to whether they come within the letter of this particular act, yet when the proprietors of them advertise them and sell them as a stock food in this state, it is your duty to require them to comply with the law of this state referring to the sale of stock foods in this state, which is the act referred to in your letter.

You have also submitted to me the brief of the attorneys for the International Stock Food Company, in which it is denied that the International Stock Food comes within the purview of said statute. In this brief counsel ask this question: "Can the legislature, by merely so stating bring anything within that definition in order to bring it within the scope and operation of a certain act?" And proceeding say, "This act deals only with feed stuffs and does not, either by its title or the body of the act, name anything but feed stuffs." The answer to this question, it occurs to me, is that when the manufacturers and proprietors themselves see fit to sell an article as stock food or stock feed, and to so advertise it and put it upon the market, that they are in no position to claim that it is anything else other than that which they advertise it to be. And so long as such articles are sold as stock feeds or stock food in my opinion the manufacturers or proprietors selling or offering same for sale must comply with the provisions of the act referred to. This I believe answers your first, second and third questions propounded to me, since they all refer to the same subject matter."

How the Law Affects Dealers Outside the State.

If a manufacturer or dealer outside the state wishes to sell feeding stuff to consumers in this state, he must register and tag his goods the same as dealers in the state. Importers, manufacturers or manipulators either in or out of the state, can sell to

other importers, manufacturers or manipulators without tagging their goods. In this event, however, the importer, manufacturer or manipulator who finally sells to the consumer, must register and tag the goods.

Unless local dealers wish to purchase material from manufacturers and sell the same under their own name, it would be best for them to require the manufacturer from whom they buy the material to register and tag the same, as in this way the local dealer would not only be saved some trouble, but would also receive the benefit of the manufacturer's guarantee and the protection against adulteration afforded by the law. We would suggest in this connection that local dealers call the attention of out of the state manufacturers to the requirements of the law, and suggest that they register their goods Copies of circulars No. 6, containing the full text of the law and of this circular, will be furnished for this purpose if desired.

It is to be noted that the fact that a feeding stuff has been registered and tagged in some other state, does not obviate the necessity for registering and tagging it in this state. No tag except that bearing the fac simile signature of the Indiana State Chemist, is good in this state.

Not Necessary to Tag Feeding Stuff Sold Outside the State.

It is not necessary to attach the Indiana State tag to feeding stuff to be shipped out of the state, as the law only applies to feeding stuff sold in Indiana.

Annual Report of Sales.

The annual report of sales required by the law is for the purpose of collecting accurate statistics concerning the sale of feeding stuffs in the state. Such reports may be made up from the record of tags ordered, by deducting the number of unused tags on hand at the end of the year or by calculating from the amount of grain used in the process of manufacture. As tags are good

until used, the State Chemist has no means of knowing how many unused tags are on hand at the end of the year, and is therefore unable to furnish accurate statistics of the year's business, without having reports from individual dealers. It is not intended to make public individual information secured in this way. The same will be used only in the aggregate for statistical purposes.

Ample Time Allowed for Complying With the Law.

As was to be expected, many questions are arising in connection with the administration of the law, which will require some time to settle. In view of this fact, it has been decided to allow until July 1, 1907, for having analyses made if necessary, registering brands, ordering tags, disposing of stock on hand that it is not desired to register, and otherwise getting ready to comply with the law after that date. After July 1, the inspection work will be pushed, and it is expected that all feeding stuffs covered by the law will at that time be properly registered and tagged. Until July 1 business may proceed as usual.

In administering the law, it is the desire of the State Chemist's office to co-operate with manufacturers and dealers in every way possible consistent with the carrying out and strict enforcement of its essential features. It is not the wish of those having charge of the administration of the measure to impose unnecessary restrictions on any one. Any suggestion concerning the law will be gladly received at any time, and given careful consideration.

FORM OF TAG.

No. 3.

.....Pounds,

JOHN DOE & CO.,
of Lafayette, Ind.

Guarantees this

Doe's Wheat Bran.

to contain not less than

3.7 per cent. of crude fat.

14.0 per cent. of crude protein.

and to be compounded from the following ingredients:

Wheat Product.

Purdue University Agricultural Experiment Station, LaFayette, Ind.

Arthur Goss
State Chemist.

Not good for more than 100 lbs.

FORM OF STATEMENT AND CERTIFICATE.

The following form shows the manner in which the statement and certificate should be made out for registration:

Statement and Certificate of
CONCENTRATED COMMERCIAL FEEDING STUFF
FOR SALE.

I, John Doe, a citizen of LaFayette, of the County of Tippecanoe, of the State of Indiana, hereby state that I am the President of John Doe & Company, and as such am authorized to make this statement and certificate for and on behalf of John Doe

& Company, LaFayette, Ind., and that the said John Doe & Company desires to offer for sale in the State of Indiana Doe's Wheat Bran, a concentrated commercial feeding stuff.

JOHN DOE & COMPANY,
By John Doe, President.

And I hereby certify that said Doe's Wheat Bran, is manufactured by John Doe & Company, and the principal office of said manufacturer is at LaFayette, State of Indiana, and the name, brand or trademark under which said concentrated commercial feeding stuff will be sold is Doe's Wheat Bran and the ingredients from which it is compounded are by John Doe & Company certified to be as follows: Wheat, and said John Doe & Company also guarantee said Doe's Wheat Bran to contain not less than

3.7 per cent. of crude fat
14.0 per cent. of crude protein, (N X 6.25), and not more than 10.0 per cent. of crude fiber.

This certificate is made for the purpose of complying with the concentrated commercial feeding stuff law of Indiana, and with a full understanding that the manufacturer of the concentrated commercial feeding stuff hereby establishes the legal standard for this brand for the State of Indiana, and that after this certificate is received and filed by the State Chemist of Indiana, no change can be made in this standard.

Witness, my hand and seal this 22d day of May, 1907.

JOHN DOE & COMPANY,
By John Doe, President.

State of Indiana, County of Tippecanoe, ss.:

John Doe, being duly sworn, says that he duly executed the above and foregoing certificate. JOHN DOE.

Subscribed and sworn to before me this 22d day of May, 1907. THOMAS SMITH, Notary Public.

PURDUE UNIVERSITY

Agricultural Experiment Station

CIRCULAR No. 8.

LaFayette, Ind., October, 1907.

BEEF PRODUCTION.

I.

PURCHASING FEEDERS.

By J. H. Skinner and W. A. Cochel.

Beef production in Indiana usually follows one of two distinct lines. Either the feeder raises his own cattle and finishes them for market, which is beef production in its true sense, or he buys his stockers and feeders either from the producer or some central market and finishes them, which is beef feeding (finishing) rather than beef production.

Undoubtedly the first class, beef producers, can afford to handle nothing but the best cattle. Their problem is one of breeding and feeding. Their methods of handling stock will depend largely upon local conditions. If they have an abundance of land suitable for grazing, they may possibly afford to carry their cattle in summer on grass, in winter on rough feed until they weigh from 1,000 to 1,200 pounds; then give them a short heavy grain feed, finishing them for market at 24 to 36 months of age. This method requires a minimum amount of grain in proportion to roughage.

If all of the land is such that it will produce good crops of corn, a different system should be followed. The aim of the producer then should be to grow and fatten his animals at the same time, so that they will go on the market as prime yearlings, weighing around 1,000 pounds at 15 months of age. This method de-

mands a special type of animal, which can briefly be described as early maturing. The indications of early maturity are a broad forehead, short face, short thick neck, short legs, deep compact body, straight back, low flanks and general quality throughout. In order to finish yearlings it will be necessary to force them from the time they are weaned until they go to market. This will demand a large proportion of grain and concentrated feeds in proportion to roughage.

The second class, beef feeders, has the same problem as the beef producers in feeding. In place of breeding, they have difficulty in finding high grade beef steers, and when found, have the problem of determining how much to pay for the skill on the part of the man who has produced them. The greatest question before the feeders of Indiana today is, where can good feeders be bought at a price that will assure a profit over and above the cost of steers and the feed consumed in the feed lot?

When a cattle feeder is not a producer he is compelled to buy his feeders in one of the four following places:

1. In his immediate locality.
2. At central markets, such as Chicago, Indianapolis, Kansas City, Omaha and St. Louis.
3. In public sales of stockers and feeders, which are conducted during the fall in Indiana, Illinois, Iowa and Ohio.
4. In sections adjoining the corn belt, where feeders rather than fat cattle are produced.

Buying Locally.

Formerly it was possible to pick up a load of desirable feeding cattle, uniform in age, color, type, breeding, condition and quality in almost any section of the State. In recent years the conditions of farming have changed so much that this is no longer possible throughout the corn belt. The supply is limited, because land suitable for grain farming has advanced so rapidly in value that it is not thought profitable to keep it in permanent pastures. A greater revenue per acre can be obtained at present by growing corn. Furthermore many farmers consider that it is no longer profitable to keep a cow a year solely for the calf she produces, hence they have sold off their well bred cattle and depend upon

buying elsewhere. And again a large proportion of cattle feeders have retired from their farms, moved to town and are renting their farms. Under prevailing conditions a renter cannot afford to stock a farm, as his lease has to be renewed annually, while the man who produces cattle must necessarily be able to live on the same farm through a series of years. The exceptionally high prices paid for butter during the last few years, together with the increased price for veal calves, have tempted many farmers to sacrifice a good beef calf as veal and milk an unprofitable cow.

Not only has the supply been diminished, but the quality has declined due to the fact that a large majority of farmers keep just enough cows to supply their families with milk and butter. The result is that cows have been selected which show marked dairy form and characteristics rather than the beef type and conformation. As the cows are kept to supply dairy products it is preferable to have them come "fresh" at different times in the year, in order that the dry cows may be replaced by fresh ones. The calf crop is thus very uneven in size. Little attention is paid to the kind of a sire used as the calves being considered of little value are generally sent to the butcher as veal. Those which escape this market are frequently raised at a loss.

The use of inferior sires is common with the small farmer, as he does not appreciate the value of the pure bred sire and therefore does not feel justified in buying a registered bull of the modern beef type to use on a few cows, but instead either buys a bull calf for $20 or $30, uses him for one year, sells him at a slight advance over cost price or depends on using his neighbor's. The cows not having been selected with a view of producing typical beef calves, are of indiscrimnate breeding. Frequently beef, dairy and scrub breeding will be found in the same herd. These mated to the same bull, at different seasons of the year bring forth a calf crop lacking as much in uniformity of age, breeding, type, conformation and color as it is possible to conceive of. When a farmer has produced a bunch of high grade steers, which are best suited for the feeder it has not been due to accident but rather to thought, time and money expended for that purpose. When this has been done he fully appreciates their value and as a rule wants to feed them out.

The advantages of buying locally are

1. No expenses for traveling, feed, yardage, commission and freight.

2. It is possible to know the previous treatment cattle have had.

3. Cattle are accustomed to farm conditions, know how to eat grain.

4. Cattle are quiet in feed lot.

5. If equal in other respects native cattle will do better than others.

6. Have no soreness and stiffness due to shipping to overcome.

The disadvantages in buying locally are

1. The difficulty in securing uniformity in age, type, condition, color and breeding.

2. The producer wants to sell all of his calves or feeders, at the same time, usually depending upon the good ones to sell the poor ones. This makes it necessary for the buyer to take undesirable steers.

3. The average farmer is not thoroughly acquainted with market prices and is unable to price his stuff accordingly.

Buying in Central Markets.

Steers found in the central markets vary according to the country tributary to them, though at times cattle will be found of an entirely different type than is usually seen. This is due to the activity of shippers, who learning that there is a demand for a certain kind of cattle at one market, which is not being filled, will cater to this demand by shipping from one market to another.

Chicago.

The Union Stock Yards at Chicago is the great central market for fat cattle. In the southwest section of the yards will be found what is known as the Stocker and Feeder Division. This is usually well supplied with all grades of stockers and feeders, from inferior to the very best. These cattle have been bought up by speculators, known as "scalpers," in mixed lots, just as they come from the country and are sorted into uniform lots of feeders. They

include cattle which have come in off of grass and are not good enough for killers; steers reshipped from other markets where there has been no demand for them, steers which have been "warmed up," that is, given a short grain feed before leaving the country, but not enough to make them sell with fat cattle, and culls which have failed to do well in the feed lot. Here will also be found many steers from dairy cows, sired by beef bulls and carrying enough beef blood to have desirable (acceptable) color markings but not enough to insure beef type and conformation.

Kansas City.

Kansas City is generally considered the greatest feeder market in the country. This is due to its situation just at the edge of the range country. Here will be found a larger percentage of grass cattle and stock calves than at any other market. These cattle are drawn largely from western ranges where attention has been given to breeding cattle for beef purposes. The ranch owners come to Indiana every fall to buy our pure bred beef bulls in car load lots in order to improve their herds, thus cutting down the supply used at home. The result is that grass fat cattle from the west from July to November sell in competition with our native corn fed cattle of plainer quality. Cattle bought at Kansas City and other western markets usually have had little or no grain. The supply to select from is so large that a feeder can get almost anything he wants on the open market rather than through scalpers. There is one section of the yards given up to firms which deal exclusively in stock calves. These are largely Hereford, Shorthorn and Angus shipped in from the range and sorted into lots which are uniform in breeding, weight and age. Occasionally there will be found among them calves from dairy districts sired by Hereford or Angus bulls, possessing typical Hereford markings or black and polled like the Angus, which will prove a disappointment to the feeder. The freight rate from Kansas City and the long trip should always be considered by Indiana feeders when purchasing on that market.

Indianapolis.

The Indianapolis Stock Yards are conveniently located in the south part of the city. The supply of feeders here comes chiefly

from the rough, hilly land in southern Indiana and Illinois, though occasionally they are reshipped from St. Louis, Kansas City and other markets. These cattle vary from the very best to the inferior scrub steers, but as a rule have been raised on small farms, are acclimated, have learned to eat corn, and have been shipped only a short distance. They will recover quickly and be ready to go on full feed. The Indianapolis market has one advantage over all others for Indiana feeders. It is easily accessible and requires a short run to almost any part of the State. Chicago has the same advantage to northern, and Louisville and Cincinnati to southern Indiana feeders.

Advantages in Buying on Central Markets.

1. It is possible to get uniformity in age, color, weight, condition, breeding and quality.

2. By going to market, the feeder learns what the market demands in finished cattle and can buy accordingly.

3. At times all markets are glutted and it is possible to buy cattle at really less than they are worth.

4. It is possible to get in touch with a reliable commission firm which will keep the feeder posted as to when to buy and secure best values. He should describe the kind of cattle he wants and let them buy for him. The charges amount to about five cents per hundred, which is more than repaid by the commission man's knowledge of prices, shipping facilities and sorting of cattle.

Disadvantages.

1. There is no way of telling what previous treatment the steers have had.

2. Steers which have become stale are apt to find their way to the feeder pens.

3. It requires a week to 10 days to recover from soreness and bruises received in the yards and in shipping.

4. In buying fleshy feeders in the yards, it is necessary to bid against butchers and packers.

5. It is possible that some of the feeders have previously been in the feed lot and failed to thrive.

Buying at Public Auction Sales.

In recent years there has grown up quite a business by sending cattle, mostly calves and yearlings, from the range country into the corn belt and selling them at public auction to feeders. These cattle are usually sorted into bunches that are uniform as to size and color markings. At all auctions they are sold to the highest bidder, sometimes well worth the money; at other times, for more than they are really worth. These cattle coming direct from the range must necessarily be handled carefully at first, so that they overcome their natural wildness and timidity.

The advantages are

1. Uniformity in age, color and breeding.
2. There is no commission, feed bill and yardage to pay.

The disadvantages are

1. The cattle have just recently been shipped a long distance; hence are sore and stiff.
2. They frequently sell for more than they would bring in the open market.

Since the western branches have begun using pure bred beef bulls on the ranges, a few of the larger feeders have made a practice of going directly to the southwest for their steers. They have a large number of cattle to select from and see the kind of breeding stock back of them. It is customary to allow a 10% "cut back" when buying in this way.

Buying in Grazing Sections Adjacent to the Corn Belt.

There is in southern Indiana, Illinois and central Missouri, a large amount of rough and broken land which is suitable only for grazing. As a rule these soils are especially adapted to the growth of blue grass and clover, are supplied with an abundance of water and the grazing season is long. There is not enough corn grown to finish all the cattle produced: hence they go to the markets in the fall of the year as grass fat cattle or as feeders. This seems to be the logical place for the corn belt feeder, who does not produce his own feeders, to secure his cattle. During the past two years the Experiment Station has bought two year old feeding cattle in Lawrence, Ripley, Jennings and Orange counties, and has found that these cattle can be bought and handled at a profit.

The advantages in buying feeders in southern Indiana are

1. There is low freight rate with no expense attached for yardage and commission.

2. The cattle are acclimated, and possess capacity and constitution.

3. They are strictly grass cattle and are gentle.

4. These cattle are shipped into the central markets, where they are sold as feeders. The shipper must have a profit and also the firm which handles them. If bought direct from the producer of course the freight to the yards and the middle man's profits are saved. That it is not the present rule is due largely to the fact that the average run of cattle produced in these sections indicate that no particular attention has been paid to breeding. There are too many coarse, rough, leggy steers with plain heads and lack of quality. They do, however, possess two very desirable characteristics; they have constitution and capacity, which insure rapid and economical gains. In those communities, however, will be found some cattle of a most desirable type. These are produced by men who appreciate the value of good blood and have not hesitated to use it.

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 9.

LaFayette, Ind., November, 1907.

COMMERCIAL FRUIT GROWING.

By James Troop and C. G. Woodbury.

It is the purpose of this circular to discuss some of the possibilities of financial success in commercial horticulture in Indiana and to point out some of the fundamentals of profitable fruit growing. It is a fact at the present time, which it is hoped will not long continue to be true, that only a small percentage of Indiana farmers are aware of the profits to be derived from the growing of fruit. Very few, especially in the southern part of the state, seem to appreciate the peculiar and especial advantages with which their country has been endowed by Nature, which seem to destine it, as soon as the true condition of affairs is realized, to develop into one of the greatest fruit producing localities in the United States. In this circular it is intended to call to the attention of Indiana farmers some of the advantages of the state in the growing of fruit, and to give a few brief hints on the solution of some of the problems which confront the prospective orchardist as to varieties, methods of planting and control of pests. Indiana possesses at the present time about 121,000 acres planted to fruit trees of bearing age. Of these fruits, the apple, as would be expected, is far in the lead with about 4,100,000 trees in bearing, while the total of the bearing trees, of pear, plum, peach and cherry is about 3,500,000. In 1906, the apple crop of the state was 4,798,300 bushels. Although the largest crop in years, there was not enough apples to supply Indiana markets. Instead of Indiana being an apple selling state then, as might be expected from its

abundant natural resources, it is an apple buying state, and although there are thousands of acres ideally adapted to the growing of the king of fruits, the quantity produced is not great enough to supply home markets.

The climate, the type of soil and the conformation of the land in southern Indiana point naturally to fruit growing. The great markets within easy rail and river communication invite it. The records of orchards now in bearing prove and illustrate the possibilities. In regard to the profits of the business, it may be said that apple orchards in southern Indiana, have made as high as $100 per acre in a single season. Other branches of horticulture are successful also, as well as the growing of tree fruits. There are small fruit growers in Indiana who made in 1907 as high as $275 per acre; not for one acre only but from plantations of from 10 to 30 acres; strawberry growers have made $200 and more per acre; melon growers have netted over $200 per acre In almost every branch of horticulture, such results as these are being achieved every year. These results are obtained by men who *know how*. Now very often, the man who does not know has an idea that successful fruit growing is a mysterious process, requiring some especial knack or talent which the average man does not possess, and lacking which he is sure to fail. Such an idea is far from the truth. Profitable fruit growing requires as much and no more skill and brains than is required to succeed in any other line of agriculture. There are no mysterious secrets about it, only a few principles which anyone can grasp with a little study.

Occasionally, however, we see men engage in the fruit business with the expectation of getting something for nothing. They set their trees carelessly, leave them to shift for themselves after they are set, and then simply because they are in a locality abundantly favored by nature for the production of good fruit, they neglect to spray and throw the whole responsibility for the growing of a good crop upon Providence. The result is certain. In years of plenty they may have considerable fruit, in other years none. At no time do they have a No. 1 product and in every instance they fail of achieving the financial success which they might achieve by a little intelligent effort expended at the right time.

SPRAYING.

Spraying at the present time, while it does not solve all the problems of the orchardist, is one of the essentials of good fruit production. The fruit grower should know very definitely what he wants to spray for before going into the orchard with a spray pump. Fletcher says, "Indefinite rule-of-thumb spraying rarely



Photo by C. G. Woodbury.

Fig. 1.—The power sprayer at work in the Purdue Station orchard. The first spraying for codling moth and apple scab is done in early spring. The materials used are Bordeaux mixture and some form of arsenic.

pays. Know what you are spraying for; know its life history, so that you can spray at the right time; then spray to hit the mark." There are one or two troubles, however, which are difficult, if not impossible to control by spraying alone. Among these are the fire blight of the apple and pear, peach yellows, rosette and little peach. When any of the last three appear the affected trees should at once be cut down and burned.

The appearance of fire blight is characterized by the sudden dying and turning brown of the ends of the twigs, so that they look as if scorched by fire. The disease is caused by a germ and is difficult to control by spraying. The most successful treatment is preventive, rather than curative, and consists in keeping the trees growing slowly so that the wood is thoroughly ripened. The disease is usually far worse in rapidly growing orchards, as it finds the tender, sappy wood especially favorable to its development. Some varieties, especially of pears, are apparently more resistant than others. Bartlett and Clapp seem to be especially subject to it; while Kieffer and Tyson, though not immune, are more resistant.

Thoroughness Essential. The greatest possible thoroughness of application is essential for effective spraying. It costs much more to do a poor job, than to do a good one, for a good job more than pays for itself in the improved quality of the fruit, while poor spraying is time and money thrown away. A word may not be amiss as to the mechanical condition of the spray most desirable for economy and efficiency. All liquid sprays should be applied to the plant in as finely divided condition as possible. The nearer it approaches the condition of a fog or mist the better. To secure this effect, a good nozzle and high pressure are necessary. One of the nozzles made on the principle of the Vermorel usually gives excellent satisfaction. For orchard work, extension rods are also necessary. These are preferably of bamboo lined with brass tubing, and are light, rigid and durable. For high trees, some sort of scaffold or tower on the spray wagon is necessary for the man to stand upon who holds the spray rod.

Apple Scab and Codling Moth. These two troubles are the worst which the apple grower has to contend with. The first is a fungus disease, which makes brown, rough blotches on apples and pears, the second is the insect whose larval form is the apple worm. They are discussed together here simply because there is a combination spray which is effective against both. This is Bordeaux mixture, to which some form of arsenic has been added. The Bordeaux is for the fungus and the arsenic for the codling moth.

Paris green may be added after the Bordeaux has been prepared, at the rate of one pound to 100 gallons.

Directions For Making Bordeaux. The usual formula is

5 pounds copper sulfate
5 pounds of lime
50 gallons of water.

The secret of succes in making Bordeaux is to put together as dilute solutions as possible. Figs. 2 and 3 suggest methods for

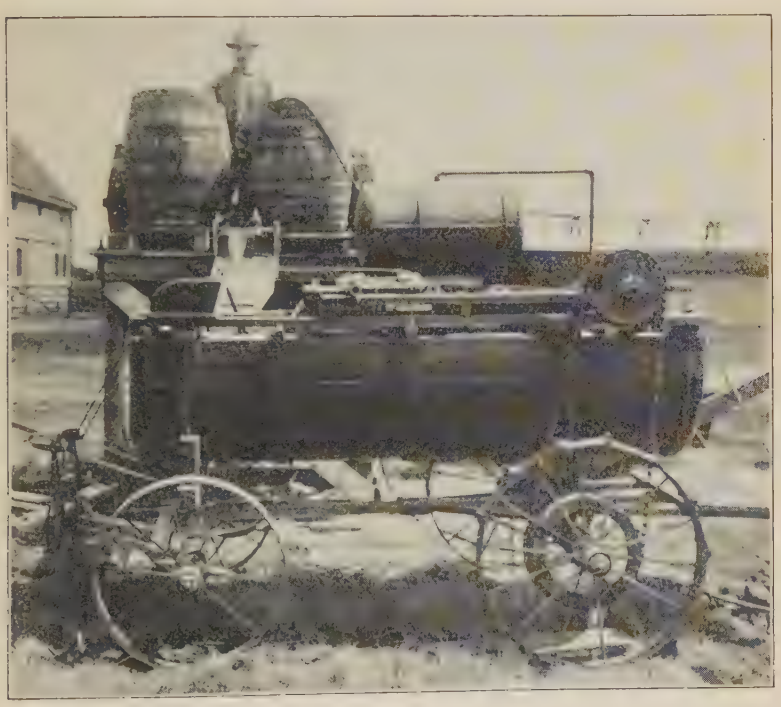


Photo by C. G. Woodbury.

Fig. 2.—Filling power sprayer with Bordeaux mixture, at the Purdue Station.

accomplishing this. Fig. 2 is a cheap and efficient outfit for preparing Bordeaux, which is in use at the Purdue Station. The dilute copper sulphate solution is prepared in one set of barrels, the lime in another, a third set being reserved for the stock or concentrated solutions. The dilute solutions are mixed by being run together into the spray pump, as shown in the illustration. Fig. 3 is a more

elaborate outfit for preparing spray materials on a large scale, which is in use in one of the commercial orchards of the state. Dissolve the lime and copper sulphate separately and dilut each solution as much as possible before mixing. Don't mix concentrated solutions. If this is done, with the idea of diluting to spraying strenght later, the mixture curdles, and a thick, heavy precipitate is formed which

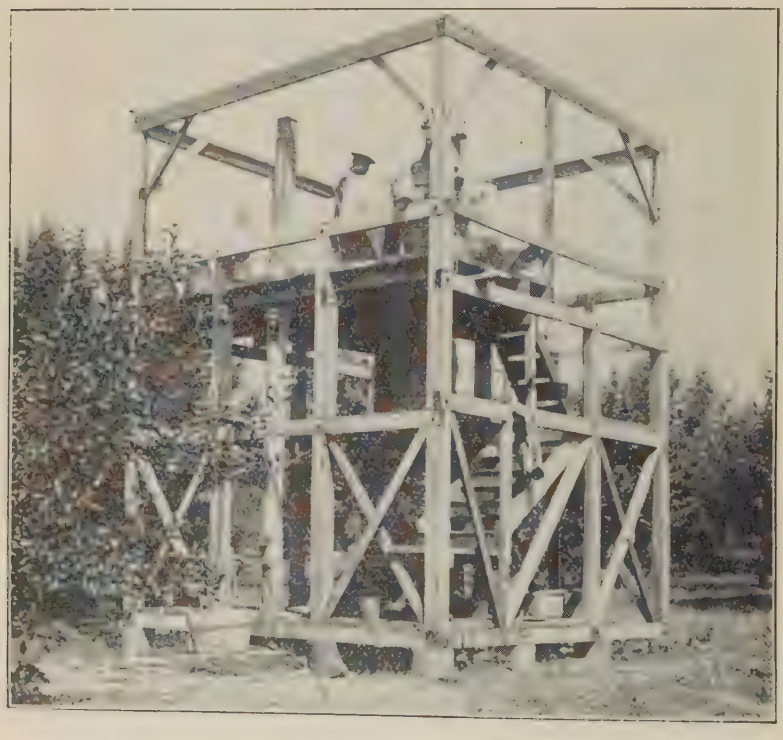


Photo by C. G. Woodbury.

Fig. 3.—A serviceable outfit for preparing spray mixtures on a large scale, in use in central Indiana.

settles so rapidly that it is impossible to do a gool job of spraying. Strain the mixture when putting into the spray pump.

To control the scab fungus and codling moth, apply Bordeaux mixture to which Paris green has been added, just before the blossoms open; again just as soon as the blossoms fall; and again about 10 days later.

San Jose Scale. One of the serious enemies which the fruit

growers of Indiana have to deal with at the present time is the San Jose scale. Every owner of fruit trees ought to become familiar with this insect so that he can recognize it at sight and to inform himself as to the best methods of dealing with it. This creature is a very small insect and when present in great numbers it coats the infested limb with a rough, ashy gray or almost black deposit, often covering the bark. Fig. 4 shows a peach limb thoroughly incrusted with the scale and appearing about the size it would to the naked eye. On the young and tender growth and on the fruit of the apple and pear the San Jose scale often causes small, red discolorations. These red danger signals may make even a slight infestation quite easy to find. Fig. 5 shows a Duchess pear badly infested with the scale.



Photo by C. G. Woodbury.

Fig. 4.—Peach limb encrusted with San Jose scale; the bark is completely covered.

This pest need drive no horticulturist out of business, however, nor keep anyone from planting fruit trees. The control of the scale is not especially expensive and a man can keep his own orchard in healthy condition, even though his neighbor's orchard over the fence may be dying from the effects of the scale. The secret of success lies in taking the matter in hand early, and keeping at it systematically; not even the San Jose scale can keep up with the wide awake orchardist, armed with a good spraying outfit and a little determination.

Lime Sulfur Wash. This is the best and cheapest remedy for San Jose scale. It is caustic in its action and must be used when

the trees are dormant, after the leaves are off in the fall, or before the buds open in the spring. The formula is

15 pounds of flowers of sulfur
20 pounds stone lime,
50 gallons of water.

Slake the lime in a few gallons of hot water and add the sulfur which has been previously made into a thin paste. Then dilute to about 25 gallons and boil for 45 minutes. Dilute to 50 gallons, strain into the spray tank and use while fresh.



Photo by C. G. Woodbury.

Fig. 5.—Duchess pear badly affected by San Jose scale. Reduced

Care and Management of the Orchard.

There are a few facts and principles which the prospective fruit grower should keep in mind and there are some fundamentals to success in commercial horticulture which depend upon the man rather than his surroundings. To be a successful fruit grower a man must like the business. He must be willing to spend some time and energy in the orchard at other seasons of the year



Photo by C. G. Woodbury.

Fig. 6.—A succesful Indiana apple orchard. Note the sod mulch, the low heading and the extremely heavy crop.

than harvest time. He must understand that young and growing trees, in order to do as well as they are capable of doing must receive some care and attention as well as growing corn or growing calves.

Varieties. The question of varieties is an important one and should receive careful attention. For commercial purposes it is best to have only a few kinds and to have enough of a kind to pick, pack and market at a time so that they will command the attention of buyers. For southern Indiana, the winter sorts are proving most profitable. A good plan for the intending planter to follow, is to look over his county and see what varieties are doing best. In this way he can make no mistake. The following lists of market varieties are taken from Bulletin No. 102 of this Station:

Northern Indiana:—Baldwin, Grimes' Golden, Hubbardston, Jonathan, King, Northern Spy, Oldenburg, Rhode Island Greening, Stark, Tetofsky, Wealthy, Yellow Transparent, York Imperial.

Central Section:—Ben Davis, Gano, Grimes' Golden, Indiana Favorite, Jonathan, Maiden Blush, Northwestern Greening, Oldenburg, Pewaukee, Rome Beauty, Stark, Twenty Ounce, Wealthy, Winesap, Yellow Transparent, York Imperial.

Southern Section.—Benoni, Ben Davis, Gano, Grimes' Golden, Jonathan, Rome Beauty, Winesap, Yellow Transparent.

Management. After the varieties have been decided upon, other problems present themselves for solution. The first thing to consider is the kind of tree. Many make the mistake of buying too large trees. It must be borne in mind that the planter is not spending money for wood. What he is really buying is the future of his trees. Well grown two or three year old trees usually have better prospects in life when set in an orchard than four or five year olds. The young trees are still plastic and can be moulded to the grower's ideal. The older ones have their characters formed to a great degree and cannot easily be changed; moreover the wood is older, the root systems are developed so that transplanting is a greater shock and it is with greater difficulty that they become established.

Don't set too close. H. E. VanDeman, ex-Pomologist of the U. S. Department of Agriculture, recommends 50 feet as proper for apples. For Southern Indiana, however, 40 feet is probably sufficient. Many make the mistake of setting their trees 25 or 30 feet, and then find later that their orchards are being seriously injured by overcrowding, when they should be in the prime of life.

Don't double crop the land. A good crop of apples removes about as much plant food as a crop of wheat. It is poor policy

to try to get both. The orchard should be cultivated if possible up to bearing age. If the site is so hilly that cultivation is liable to cause serious washing of the soil, the young trees should be mulched. A good mulch of straw or grass serves much the same purpose as clean cultivation, in keeping the ground moist. There is danger from mice, which are liable to shelter in such a mulch, however, unless measures are taken to protect the trees. For this purpose wire netting is very satisfactory or tree protectors of veneer. If the orchard is on comparatively level ground, the raising of some low-growing hoed crops is often of advantage. Hay or grain, however, are out of place in the orchard and young trees especially suffer from their presence.

NOTICE.

A full discussion of the problems of apple growing and spraying will be found in Bulletins 102 and 118 of this Station. If you desire the Bulletins, write to Purdue University Experiment Station, La-Fayette, Ind. The Horticultural Department is prepared to give advice and assistance to prospective fruit growers and will be glad to hear from you.

PURDUE UNIVERSITY

Agricultural Experiment Station

CIRCULAR No. 10.

LaFayette, Ind., November, 1907.

The Use of Fertilizers on Southern Indiana Soils.

By ARTHUR GOSS.

Investigations have been in progress at the Experiment Station for a number of years past, with a view to ascertaining the methods of fertilization, best adapted to the different soils and crops of the state. In this connection tests have been made on practically all the important soil types and have involved the use of such materials as dried blood, nitrate of soda, bone, acid phosphate, dicalcic phosphate, rock phosphate, muriate of potash, sulfate of potash, carbonate of potash, ashes, slaked lime, ground limestone, iron sulfate, iron hydrate, magnesium sulfate, magnesium carbonate, sodium sulfate, copper sulfate, carbon black, muck, clay, straw manure and legume crops.

Some of the problems being investigated in this connection are—1. The test of different fertilizer and legume crop combinations on different soils and crops of the state with the view of determining the most profitable combination to use in different cases. 2. A study of the lasting effect of fertilizers. 3. A comparison of different forms of nitrogen, phosphoric acid, potash and lime compounds, with a view of determining the best and most economical form to use in given cases. 4. A comparison of commercial fertilizers with manure. 5. A comparison of the effect of fertilizers on drained and undrained land. 6. A study of the

injurious effect of fertilizers on the germination of corn. 7. A study of the effect of fertilizers in lessening the effects of bad seasons and insect ravages. 8. A study of the effect of fertilizers in aiding to secure a stand of clover. 9. An investigation to determine the most profitable amounts of fertilizer to use. 10. A study of the effect of different fertilizers on the quality of the produce. 11. A study as to whether the continued use of fertilizer will injure the land.

While it is impossible at this time to go into details as to the results that have been secured in this work it may be said in a general way that while occasionally soils are found that do not respond to fertilizers, usually some combination has been found that has produced handsome profits and not infrequently enormous returns. There is for example no question that the application of potash in considerable quantities on muck soil is very profitable in connection with the growing of corn and other crops. It also seems certain that the liberal use of fertilizer on the potato crop is highly profitable, and that fertilizer will usually pay well on the wheat and corn crops, if used in the proper proportions and right amounts. The work that has been done emphasizes the fact however, that in order to secure the best results it is necessary to understand the needs of the particular soil, and crop to be used. It is a very easy matter to waste a large amount of money in the use of fertilizers through the application of unnecessary elements, and improper forms of plant food, and the only wonder is that such satisfactory results are secured under the present haphazard system in vogue. There is not the slightest doubt that a large and profitable increase in crop production could be brought about in the state by a more systematic and intelligent use of fertilizers.

The following illustration, Fig. 1, shows the results secured in a fertilizer test in Clinton County the past season. In this experiment 300 pounds per acre of a fertilizer, containing four per cent. of nitrogen, eight per cent. of available phosphoric acid, and four per cent. of potash, were used on the plot labeled KPN. The nitrogen was derived from dried blood, the phosphoric acid from acid phosphate and the potash from muriate. The plot marked O had no fertilizer. The KN plot had the same treatment as the

KPN plot with the exception of the acid phosphate, which was omitted. It will be seen that phosphoric acid was the element most needed in this experiment. The addition of the acid phosphate more than doubled the yield, causing an increase of 18 bushels per acre at a cost of $1.20.

FIG. 1.

Fertilizer test with wheat, Clay soil, Clinton Co., 1907.



35 bushels per acre. Cost fertilizer $4.08 per acre.

15 bushels per acre.

17 bushels per acre. Cost fertilizer $2.88 per acre

How to Determine the Fertilizer Requirements of a Soil.

One of the most common inquiries received at the Station is, how the fertilizer requirements of a soil may be determined. It is a very common and natural belief that the proper way to do this is by analyzing a sample of the soil in question. This method would doubtless be satisfactory if it were not for the fact that it is almost impossible to tell by analysis how much of the plant food present is available. The total amount of nitrogen, phosphorus, potassium and other plant food materials can be ascertained by analysis, but as by far the greater part of this material cannot be secured by the plants, and the proportion that can be obtained varies decidedly in different soils, and with different crops, the determination of the total amount is of rather uncertain value in showing the fertilizer requirements of a soil. The method recommended by the Station for ascertaining this is by the trial of a series of fertilizer tests on the soil itself. If such

a test is undertaken, however, it should be carefully and systematically conducted or it is likely to be of very little value. The Station will be glad to furnish anyone requesting the same printed directions and diagrams showing the proper arrangement of plats and fertilization of the same, for making such a test.

Crop Producing Power of Southern Indiana Soils.

The table given below (Table 1) was prepared in order to show the relation between the plant food present in Southern Indiana soils and the number of crops which could be produced by the nitrogen, phosphorus and potassium in the first six inches of these soils, provided it were possible to remove all of these elements by cropping. As has already been pointed out, however, most of the supply of these elements in the soil is in an unavailable form and hence the number of profitable crops that could actually be produced without the addition of these elements from some outside source would be very much less than indicated by the figures.

TABLE I.

No. of Crops which the Nitrogen, Phosphorus and Potassium in the first six inches of Southern Indiana clay soils could produce if same were all available.

Amount per Acre	N	P	K
Corn and Stalks, 50 bu	17	31	749
Wheat and Straw, 20 bu	53	66	2108
Clover, 2 tons	22	79	350
Timothy, 2 tons	36	57	856
Potatoes, 100 bu	67	143	1069
Apples, 300 bu	92	800	1081

Of course most crops feed somewhat deeper than six inches, but it is to be noted that the supply of nitrogen and phosphorus, is considerably less in the sub soil than in the soil. As a matter of fact, the supply of available phosphorus and potassium and particularly the phosphorus, is practically exhausted in many of

the clay soils in the southern portion of the state at the present time, and if profitable crops are to be secured in the future, the supply of these elements must be kept up from some outside source.

Fertilizer Tests on Southern Indiana Soils.

Tests have been conducted by the Station on many of the soils of the state during several years past for the purpose of ascertaining which of the three essential plant food elements are most deficient. The following table shows the result of a few typical tests of this kind on soils in the southern part of the state. In this table, as well as elsewhere in this circular, N stands for nitrogen; P for phosphorus, and K for potassium.

TABLE II.

Results of Fertilizer Tests on Southern Indiana Clay Soils.

Fertilized with	Wheat—1904 Scott Co.	Corn—1905 Jennings Co	Corn—1906 Clay Co.	Wheat—1907 Ripley Co.
	Bushels per acre			
Nothing	4	43	69	20
N—P—K	31	64	80	28
N—O—K	9	51	72	21
N—P—O	21	53	81	22
O—P—K	23	63	83	26
	Dollars per acre			
Cost P—K	$2.58	$1.20	$.90	$2.16
*Profit P—K	13.57	6.80	4.70	3.84

*Increase in value of crop after paying for fertilizer.

By referring to the table, it will be seen that the element phosphorus was deficient in all these soils as is shown by the smaller yields on the plats receiving nitrogen and potassium than than on the plats receiving all three of the elements. It will be

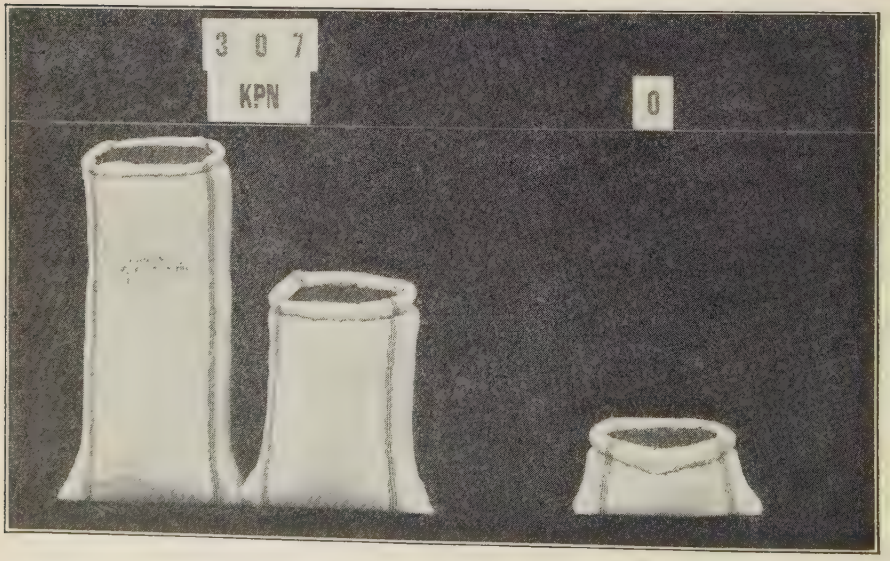
noted that potassium also increased the yield in three cases out of four, but to a lesser extent than the phosphorus. That the application of phosphorus and potassium to these soils was very profitable is shown by the financial statement at the end of the table.

In Fig. 2 is shown the amount of wheat secured on the unfertilized plats and on the plat receiving the complete fertilizer in the Scott County experiment. While this is perhaps rather an extreme case, which could not be duplicated every time, it is the result of a carefully conducted experiment, and shows the yields actually secured on this soil.

The fertilizer applied to the KPN plat consisted of 60 pounds of dried blood, 200 pounds of acid phosphate and 30 pounds of muriate of potash per acre, and cost at prices prevailing at the time this experiment was conducted, $3.20 per acre. The increase in yield due to the fertilizer was over 26 bushels of wheat per acre.

FIG. 2.

Fertilizer test on wheat, clay soil, Scott Co., 1905.



31 bushels per acre.

4 bushels per acre.

The Use of Legumes.

As the supply of nitrogen, phosphorus and potassium must be maintained in the soil, if profitable crops are to be secured the question naturally arises, as to the best and most economical method of supplying them. Fortunately, nitrogen, which is much the most expensive of these elements can be secured from the inexhaustible supply of this element in the air by growing legume crops, such as clover, cow peas or soy beans, which have the power of taking nitrogen from the air. Ordinary crops, such as corn, wheat and timothy, do not have this power, and are dependent on the supply in the soil. By turning under legume crops, the grain crops and other non-legume crops are able to secure the nitrogen necessary for their growth from that present in the decaying legume material. This affords by far, the cheapest source of nitrogen for such crops.

As a matter of fact, it is very doubtful if it would pay to feed nitrogen in the form of commercial fertilizer to grain crops, particularly corn. A 75 bushel crop of corn and stalks removes about 140 pounds of nitrogen from the soil. As this is worth in the form of commercial fertilizer at present prices, about 20 cents per pound, it will be seen that there is about $28.00 worth of nitrogen in a 75 bushel crop of corn, and as it is impossible to recover all the nitrogen supplied in the form of fertilizer, it would take considerably more than this amount to produce 75 bushels of corn. As a matter of fact, it can be seen that it will be absolutely necessary to resort to the use of legumes or some cheaper source of nitrogen than that of commercial fertilizers if corn production is to be profitably maintained on our soils.

It is probable, however, that a small amount of readily available nitrogen could be used to advantage in this connection to give the crop an early start and carry it along until it was able to use the more slowly available nitrogen in decaying legume or other nitrogenous material in the soil, and this would be of even more importance in the case of wheat, as nitrification of the organic matter in the soil has practically stopped during the early period of its growth in the fall.

The plowing under of legume crops also serves another important purpose in the soil by keeping it loosened up and in good

physical condition. This is very important and such crops should always be used in connection with commercial fertilizers for this reason if for no other.

While the use of legumes is of the highest value in maintaining the nitrogen supply in the soil and keeping it in good physical condition it must be remembered that these crops do not add an ounce of phosphorus, potassium or other mineral elements to the soil, and if such crops are removed the soil is poorer in these elements than before they were grown. To be sure, deep rooted crops, such as clover, are able to bring up more or less mineral elements from the sub soil, until the supply there is exhausted, but this is simply putting off the period of complete exhaustion of these elements a little longer. As a matter of fact, many soils in the southern part of the state are at present time unable to grow clover successfully and this condition must inevitably increase, unless the supply of phosphorus, potassium, and in many cases, lime, is kept up from some outside source.

Amount of Crop Equivalent to the Nitrogen, Phosphorus and Potassium in 100 Pounds of 2—8—2 Fertilizer.

The following table was prepared in order to show the relation between the amount of plant food present in an ordinary commercial fertilizer and the amount of crop which this represents.

TABLE III.

Amount of Crop which N—P—K in 100 pounds of 2—8—2 Fertilizer could Produce.

Amount per acre.	N	P	K
Corn, bu.	1	12	2
Wheat, bu.	1	12	2.7
Clover, cwt.	1	21	1
Timothy, cwt.	1.6	15	2
Potatoes, bu.	7	95	7
Apples, bu.	30	1600	21

Stalks and straw included with corn and wheat.

By referring to the table, it can readily be seen that the common practice of applying a small amount of 80 or 100 pounds of a fertilizer containing two per cent. of nitrogen, eight per cent. phosphoric acid and two per cent. of potash, could not be depended upon to maintain the fertility of the soil for growing grain crops. The nitrogen and potash in 100 pounds of such fertilizer, it will be seen is really a rather insignificant factor and would be useful more for the purpose of giving the crop a start than as a permanent source of food. The amount of phosphorus would come nearer answering this purpose, but is still far short of the amount necessary to permanently mintain fertility. Undoubtedly considerably more of both phosphorus and potassium will have to be applied to the soils of Southern Indiana than that present in 100 pounds of 2—8—2 fertilizer, if the fertility is to be maintained. As phosphorus is more deficient in these soils than potassium, it is reasonable that it should be present in the fertilizer in larger amount than the latter, but the amount of even the potassium in the fertilizer indicated above, is without doubt considerably short of that necessary to maintain the fertility of these soils. No mention is made of the nitrogen in this connection, because it is assumed that most of this element will be secured from legumes.

Rock Phosphate Compared With Acid Phosphate.

As phosphorus is undoubtedly the most deficient element in Southern Indiana soils, the question of the cheapest and best source of supply of this material becomes a very important one. Phosphorus can be secured from bone, acid phosphate, rock phosphate, basic slag, and a number of other substances containing that element. Nearly all the phosphorus used in commercial fertilizers in this state is in the form of bone or acid phosphate.

Rock phosphate is a natural product found in large quantities in Tennessee, Florida and elsewhere. This material is a compact form of phosphate of lime and is used very extensively in the manufacture of acid phosphate. As this material can be had for about half the price per ton of acid phosphate, and at the same time contains about twice as much phosphorus as the latter, it affords a much cheaper source of that element than either acid

phosphate or bone. For that reason, it has been extensively recommended in Illinois and elsewhere as a phosphatic fertilizing material.

In order to determine the relative values of rock and acid phosphate, experiments were started in Scott and Marion counties in the spring of 1904. In these tests, 1,000 pounds per acre of rock phosphate and the same money value of acid phosphate were applied to adjoining plats. At the time these experiments were started, acid phosphate was considerably cheaper than at present and it was estimated that 715 pounds of 14 per cent acid would cost the same as 1,000 pounds of rock. The 715 pounds of acid phosphate contained about one-third as much total phosphorus as 1,000 pounds of rock phosphate. In both experiments, but one application of fertilizer was made, the entire amount being applied the first season. In the Marion county experiment, the crops on the different plats were harvested for two years, while in the Scott county experiment, they have been harvested for four years. The results secured can be seen by referring to Table 4. The results secured the third season in the Scott county experiment, are also shown in Fig. 3, page 11.

TABLE IV.

Rock Phosphate vs. Acid Phosphate.– Same money value.

Amount per acre.	Clay Soils.					
	Marion County		Scott County			
	Corn 1904	Wheat 1905	Corn 1904	Wheat 1905	Corn 1906	Wheat 1907
	Bushels per acre					
Unfertilized	20	3	Crop failure	5	18	7
Rock phosphate, 1000 pounds	20	6		8	38	13
Acid phosphate, 715 pounds	27	16		15	33	11

Cost fertilize per acre at time of application, $5.00.
Profit per acre in four years from rock phosphate in Scott county, $11.55.
Profit per acre in four years from acid phosphate in Scott county, $13.50.

By referring to Table 4, it will be seen that during the first and second years, the rock phosphate produced little effect in either experiment, while the acid phosphate very materially increased the yields in both cases. During the third and fourth seasons, however, the rock produced very striking results in the Scott county experiment, even forging ahead of the acid.

By referring to the financial statement for the Scott county experiment, which will be found at the bottom of the table, it will be seen that both the rock and acid phosphate produced excellent returns in the four years covered. It will be noted that the gains during that period were nearly the same, but slightly in favor of the acid phosphate.

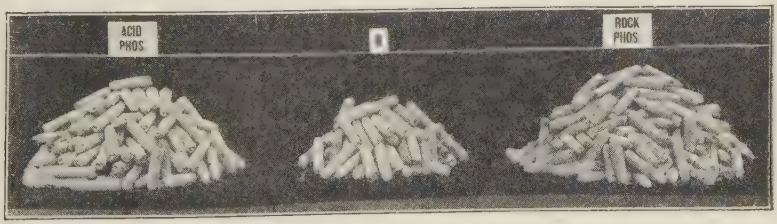
This and other similar investigations in progress, lead us to believe that rock phosphate is a cheap and effective source of phosphorus where immediate returns are not required. Its use should be considered more in the nature of an investment than as a means of securing results in a single season, for which purpose it would undoubtedly prove disappointing. For quick returns, acid phosphate or some other readily available form should be used.

Will Fertilizers Wash Out of the Soil?

It is often asked if fertilizer, especially when applied in amounts in excess of present needs, will not wash out of the soil. Fig. 3 presents some rather striking evidence on this point so far at least as phosphorus is concerned.

FIG. 3.

Experiment showing lasting effect of phosphorus on Clay soil, Scott county. Fertilizer applied three years before.



Bushels per acre, 33. Bushels per acre, 18. Bushels per acre, 38.

In the above experiment heavy applications of rock and acid phosphate were made three years previous, none being applied afterwards. It will be noted that both are still showing marked results. Similar results have also been secured with potash in other experiments and it is believed that little fear need be entertained of serious loss by leaching of either phosphorus or potassium on ordinary Indiana soils. Nitrogen on the other hand is readily washed out and should not be applied much in excess of what can be taken care of by the immediate crop. Nitrate of soda is usually best applied to wheat or grass as a spring dressing.

Does Fertilizer Injure the Land?

It is often asked if the use of fertilizer will injure the land. The following table offers about the best answer to this question obtainable. The experiment cited is being conducted at Rothamsted, England, and has been in progress for more than 50 years. No results covering anything like so long a period of time, are obtainable in this country.

TABLE V.

Continuous Wheat, Rothamsted, England, from 1852 to 1902.

Pounds of fertilizer applied annually.			Average 1852 1902	Yield in 1902
			Bushels per acre	
Unfertilized			13	13
Ammonium Sulfate 600	Acid Phosphate 350	Potassium Sulfate 200	37	45
Manure 14 tons annually			36	42

By referring to the table it will be seen that the application of a very large quantity of fertilizer to wheat each year for 50 years has not only not injured the productiveness of this soil, but has, in fact, actually increased the average annual yield from 13 to 37 bushels per acre. It will also be noted that the yield on the fertilized plats the last year was 45 bushels per acre, while the

yield on the unfertilized plats the same year was 13 bushels per acre.

The phosphorus used in this experiment was in the form of acid phosphate and was applied at the exceptionally large rate of 350 pounds annually. It seems very evident that the use of this material did not injure the soil in this case. It is to be noted, however, that this soil, while clay and somewhat similar to the clays of Indiana, contains more lime than our clays. This would tend to counteract any acidity in the soil that might be caused by the continuous use of acid phosphte. Should the use of acid phosphate in this state cause acidity of the soil, this could doubtless be readily overcome by the occasional application of lime or ground limestone.

On the whole, we do not believe there is any danger worth mentioning of injuring the soil by the rational use of fertilizers, provided fertilizing crops are plowed under regularly to keep up the supply of organic matter in the soil, and keep it in good mechanical condition.

Recommendations.

As a means of permanently maintaining the fertility of Southern Indiana soils, we would recommend:

1. The feeding of as much of the produce grown on the land as possible and the return of the manure to the soil.

2. The practice of a systematic rotation of crops containing one or more legume crops in the series.

The liberal use of clover, cow peas or other legume crops is considered essential in order to keep up the nitrogen supply and keep the soil in good mechanical condition.

If difficulty is experienced in securing a stand of clover, another legume such as cow peas, should be tried, but this would necessarily be in the nature of a temporary relief measure. A top dressing of manure will often materially aid in securing a stand of clover.

To put the land in condition to grow clover and other legume crops permanently liberal applications of phosphorus, potassium and often lime, should be made.

3. There is not the slightest doubt that much larger quantities of phosphorus, and also more potassium and in many cases lime will have to be applied to Southern Indiana soils if their fertility is to be improved or even maintained at the present unsatisfactory point. Sole dependence on the small applications of these elements practiced at present must inevitably mean still further decrease in productive capacity and final abandonment of the land as has already occurred in many of the older agricultural countries, including many sections of our own eastern and southern states.

It is not to be inferred from the above statement that the use of even a small amount of fertilizer is not beneficial, but the point is that under the present system insufficient phosphorus and other mineral elements are being added to maintain fertility.

4. As a means of maintaining the phosphorus supply, the application of a ton or more per acre of finely ground rock phosphate would no doubt ultimately be of great benefit. It is realized that the cost of a ton of rock phosphate is eight or ten dollars, but such an application should last a number of years and we believe would ultimately be found very profitable on land deficient in phosphorus such as the clays of the southern part of the state. Such an application should, however, be looked upon as a permanent investment instead of a means of producing immediate returns, for which purpose it would in all probability be disappointing. To produce results for two or three years until the rock phosphate becomes available some more soluble form of phosphorus should be employed as indicated below.

5. In the same way, the lime supply when deficient, may be increased by the application of a ton or more per acre of finely ground limestone or air slacked lime.

6. For maintaining the supply of available potash, the more frequent application of smaller quantities of soluble compounds, such as the muriate and the sulfate is recommended.

7. As a fertilizer for grain crops to produce results in a single season, the use of a formula containing the three essential plant food elements in the proportion of one and a half or two per

cent of nitrogen, eight per cent. of available phosphoric acid and two to four per cent. of potash is recommended. The nitrogen in this formula should be derived from blood or other animal matter, the phosphorus from acid phosphate, bone or other available forms and the potash from muriate, sulfate or other readily soluble compounds.

It is to be understood that the above formula is a general recommendation and should be modified to meet individual requirements. It will, for example, sometimes be desirable to increase the amount of potash somewhat, or in case a good crop of legume has been turned under immediately before, the nitrogen might be decreased or perhaps entirely omitted.

The 2—8—2 formula mentioned above can be secured from nearly any fertilizer manufacturer, or if it is desired to avoid paying freight on a lot of inert filler, the raw materials can be bought and the fertilizer mixed at home. This plan is recommended.

8. **For wheat**, we would recommend the use of about 300 pounds per acre of the 2—8—2 or 2—8—4 formula or its equivalent, the same being applied with a fertilizer attachment to the drill at seeding time.

9. **In fertilizing corn**, care must be taken that a large amount of the fertilizer does not come in direct contact with the seed, in which event the germination of the same might be seriously interfered with. We have, however, repeatedly applied 200 pounds or more per acre of the 2—8—2 formula to corn without injury, by distributing the fertilizer along the entire row with a fertilizer attachment to the drill or otherwise. This is the method of application recommended for moderate quantities such as the amount mentioned above. For heavier applications, we would recommend broadcasting and thorough mixing with the soil.

In a corn, wheat, clover rotation, the clover should be plowed under for the corn, as the corn crop not only requires more nitrogen than wheat, but is also better able to make use of this element in the form of organic matter than the latter.

10. **For potatoes**, we have found a liberal application of fertilizer almost always gives excellent financial returns. Our experiments would lead us to recommend for this crop in this state

about 1,000 pounds per acre of a fertilizer containing about two per cent. nitrogen, eight per cent. available phosphoric acid and six per cent. potash. The fertilizer should be mixed with the soil in the row under the seed at planting time. For potatoes we would recommend the use of sulfate instead of muriate of potash.

It is not our purpose at this time to enter into a detailed discussion of fertilizers for all the different crops grown in the state, but simply to point out some of the fundamental principles underlying the use of fertilizers, particularly on the soils in the southern part of the state. If this has been done, the purpose of this circular has been accomplished.

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No 11

LaFayette, Ind., December, 1907

MILK PRODUCTION

I

HERD IMPROVEMENT

By Herbert A. Hopper.

THE OUTLOOK.

A certain dairyman has 285 acres in two farms, keeps 90 cows the year around and sells his milk in Chicago. During the past year the income from this herd, after deducting the cost of transporting the milk, was $11,300. He also sold $2,000 worth of hay produced the same year, which more than offsets the outlay for concentrates bought to balance the ration. Does that kind of business pay? He made it all from cows and has shown as well as need be shown the force of the statement that "The dairy cow is the rich man's pride, the poor man's living, and the business man's best investment." He is ever learning new things and says that we little realize the possibilities of the dairy cow for immediate profit and lasting beneficial effects upon the productive capacity of the farm. These are the thoughts of a plain, practical dairyman who keeps his eyes open and his head clear. Should we not pause and figure?



PURE BRED DAIRY SIRE.

A necessity on every dairy farm.

Absolutely essential in replacing Indiana's 200,000 "robber" cows with money makers.

The dairyman's best investment; the genesis of profitable milk production.



HIGH GRADE DAIRY COW.

Photographed when dry.

Year's record:

Milk	7973 pounds
Butter	448 pounds
Year's Feed	$34.73
Year's net profit	$81.74

———

200,000 PROFITLESS COWS IN INDIANA.

There are 650,000 "so called" dairy cows in Indiana. One-third are profitable, one-third just about pay their board, and the remaining one-third are kept at a dead loss to the owner. We have evidence of this sad fact. Thousands of men are keeping tens of thousands of profitless cows. Do they know it? Some do, others do not. This is a tremendous leak that cannot be stopped too quickly. How shall it be done?

ACCOUNTS MUST BE KEPT.

Weigh the milk from each cow and test it for butter fat. Too much trouble? You cannot afford to do otherwise. Guess work is keeping more men with their noses on the grind stone than anyone dare say. Keep a record of your herd and be a free man.

TESTING. THE FIRST STEP.

Any man, woman or child can learn to operate the Babcock test and all can afford at least a $5, four bottle outfit for the farm. Its use is imperative unless other arrangements are made. Knowing the cost of her ration, the profit from each cow can be determined through the weight and test of her milk. From the same amount of food one cow may produce three times as much milk and butter fat as another under like conditions. With any given cow the test may vary from day to day and week to week throughout the lactation. Since the butter fat is the most variable and the most valuable constituent of milk, it is the part of wisdom to test and thereby separate the profitable from the unprofitable. This leads to the second step.

GRADING. ITS VALUE SUBSTANTIATED.

Wherever great progress has been made in milk production, the pure bred dairy sire has been employed to bring it about. In twenty herds studied by the writer there was an average of 2096 pounds of milk and 86 pounds of butter fat per cow per year in favor of grading up with a pure-bred dairy sire. This amounts, in a herd of 40 cows, to $860 greater annual return than from scrubs. All records and all rational breeding prove the wisdom of this practice. Test the cows, breed the good ones to a pure-bred dairy sire, and rear the



A FAIR DAIRY HERD.

Obtained from inferior cows as the result of eight years continuous use of a pure-bred dairy sire. Average annual profit per cow, $45. Such results are within the reach of all.

heifer calves. Continue to use a sire of the same breed on the herd, changing only when necessary. Don't change breeds. Don't use a "scrub" bull. The day is passed when other than a pure-bred sire should be found upon a dairy farm. The sires are available at reasonable prices; buy one and thus insure yourself and family a substantial bank account ten years hence.

PURE-BRED SIRE A PAYING INVESTMENT.

A calf may be given a pure-bred sire at an additional outlay of less than two dollars, depending upon the size of the herd and the kind of sire selected. Good bulls may be obtained at $100 and are cheap at that price. The sire should get 30 calves per year for five years, half of which will be females. Ignoring the males the extra cost in service to secure the females is $1.33 per head. These heifers, if well cared for until that time, will produce as much at 2 years as their dams at full age. At maturity they will surpass their ordinary dams by 100 pounds of butter fat per year which is equal to $25 or the interest on $500 at 5 per cent. It costs no more to raise them and they are decidedly more profitable to the dairyman.

FEWER COWS—MORE MONEY.

'Tis quality of cows rather than quantity that counts. It never pays to keep a really poor producer. Reduce the herd half if necessary; it's profits you want. Apply the scales and test to the whole herd and an ax to the "robber" cow. A certain dairyman had ten cows that gave him a total profit for the year on the whole herd of only $81.20. The six best cows separately would have profited him $82.62. Four cows were kept at a great loss.



A POOR DAIRY HERD.

Conditions at the end of three years grading with a pure-bred dairy sire. A striking contrast to the former herd, however, the influence of the sire is being felt. Annual profit, $20 per cow.

GOOD COWS ARE MONEY MAKERS.

The increasing demand for milk indicates that there is money ahead for the wise dairyman. Good cows require the attention of a good man in order to be profitable. Abundant food, congenial stables and kind treatment are essential. When these can be assured, fill up the stables with high-grade cows and success is yours. Remember that the low producer is a bad investment at any price, but that the cow liberally endowed with dairy capacity is always a powerful factor for good upon the farm. The sire is often much more than half the herd and through his purity of breeding the profitable cow must always be sought.

———

The Purdue Experiment Station at LaFayette, Indiana, is interested in you personally and wants to know more about you and your business. Doubtless you will want further information along the lines here indicated, in which case address the Department of Dairy Husbandry, Purdue Experiment Station, LaFayette, Indiana, which will help you.

PRESERVE THIS CIRCULAR.

PURDUE UNIVERSITY
Agricultural Experiment Station

CIRCULAR No. 12.

LaFayette, Indiana, May, 1908.

BEEF PRODUCTION.

II.

METHODS OF BEEF PRODUCTION IN INDIANA.

By J. H. Skinner and W. A. Cochel.

The information reported in this circular is the result of an investigation of the methods of beef production in Indiana, instituted by the Animal Husbandry Department of Purdue Experiment Station in 1906. A list of one hundred questions was sent to twenty-five hundred of the most successful feeders in the state with a view of securing information in regard to the extent of the business of feeding cattle, the equipment used, and the methods of feeding in vouge among feeders. In response to these inquiries, nine hundred and twenty-nine replies were received. This inquiry covered a wide range of subjects relating to cattle feeding operations so that the information obtained relates to practically every phase of the industry, such as the number, class, and age of cattle on feed at different seasons of the year; the cost of producing, maintaining and finishing cattle; the cost of buying and finishing cattle under local conditions; the relative profit accruing from the different systems of management; the methods of wintering stockers; feeding cattle on full feed; the question of feeds used, prices of feeds, yield of crops, size of farms and rotation in use, effect on fertility of soil, etc.

This circular is an attempt to summarize the reports received in such a way as to give Indiana feeders the benefit of the information. The list of questions sent out by the Experiment Station follows:—

QUESTIONS RELATIVE TO PRESENT METHODS OF BEEF PRODUCTION IN INDIANA.

EXTENT.

1. *How long have you been feeding cattle?*
2. *How many cattle do you feed annually?*
3. *Is cattle feeding on the increase or decrease in your locality?*
4. *Are you feeding as many cattle this year as usual?*

EQUIPMENT.

5. *How many acres of land in your farm?*
6. *How many acres devoted to pasture?*
7. *How many acres devoted to corn?*
8. *How many acres devoted to hay?*
9. *Do you grow clover? Alfalfa? Roots? Cow peas? Sorghum? Soy beans?*
10. *What kind of shelter do you provide for fattening steers? Barn? Open shed? Straw stacks? Timber lot? Open lot?*
11. *Do you make any provision against flies in summer or mud in winter? If so, what?*
12. *Do your cattle get lousy in winter? What do you do for them?*
13. *What is the source of your stock water?*
14. *Do you use a tank heater?*
15. *Do you use a self-feeder? If so, with what success?*

FEEDERS.

16. *Do you raise feeders?*
17. *What are the advantages in growing your own feeders?*
18. *Do you raise calves on skim milk or allow them to suckle cow?*
19. *What kind of grain and roughage do you feed a skim milk calf?*
20. *At what age do you wean calves?*
21. *Do you feed grain before weaning?*
22. *Do you produce baby beef? If so, do you allow them to lose the calf fat?*
23. *At what age do you put calves on full feed?*

24. *Do you buy your feeders? If so, where?*

25. *What are the advantages of buying feeders?*

26. *What time of year do you buy them?*

27. *What aged feeders do you prefer? What weight? What breed?*

28. *Do you feed steers three years old or over? If so, why?*

29. *Do you prefer a thin feeder or one carrying some flesh?*

30. *Do you put feeders on full feed immediately after purchase or do you carry them on rough feed for a time?*

FEEDS.

31. *How do you feed your corn? As broken ear? Snapped? Shelled? Corn and cob meal? Soaked? Corn meal? Shock corn?*

32. *Do you feed oats to fattening steers? If so, at what stage of the feeding period, and how long do you continue?*

33. *Do you feed bran? Linseed oil meal? Gluten feed? Cotton seed meal? Distiller's grain? Brewer's grain? When do you begin feeding the above feeds and how long do you continue? How much of each do you feed per head per day?*

34. *What kind of roughage do you use?*

35. *How do you handle your corn stalks? Pasture? Cut up in shocks? Shred?*

36. *Do you use silage for fattening cattle?*

37. *If so, how much do you feed per steer daily? How long do you feed it?*

38. *What crops do you put into your silo?*

39. *What are the advantages and disadvantages of feeding silage?*

40. *What kind of pasture do you have? Blue grass? Clover? Timothy? Mixed grasses?*

41. *How much pasture is required per steer when on full feed of grain?*

42. *How much when not receiving any grain?*

43. *When do you turn out onto grass?*

44. *How late do you pasture in the fall before feeding hay?*

45. *Do you feed any green crops to supplement pasture when grass begins to burn up? If so, what crops?*

FEEDING.

46. *Do you practice winter or summer feeding?*

47. *Do you feed grain to stockers? If so, how much and when?*

48. *What season do you find most profitable for feeding?*

49. *When feeding in winter do you feed in lots, or do you allow cattle to run on pasture?*

50. *Do you turn cattle which have been full fed in the winter on grass or continue to feed until finished in dry lot?*

51. *How long do you take to get cattle on full feed?*

52. *How long do you feed a full feed?*

53. *How much grain do you consider a full feed for two-year-old cattle? For yearlings? For calves?*

54. *Do you limit the amount of roughage?*

55. *How many times per day do you feed grain? Roughage?*

56. *How much roughage without grain does it take to winter a yearling? A two-year-old?*

57. *How many pounds of grain does it take per pound of gain in summer for two-year-olds on full feed? For yearlings? For calves?*

58. *How many pounds of grain does it take per pound of gain in winter for two-year-olds on full feed? For yearlings? For calves?*

59. *When feeding silage, what kind of grain and roughage do you feed?*

60. *Do you mix your grain and hay together?*

61. *What do you use for bedding?*

GAINS.

62. *What average daily gain do you get when full feeding in winter on two-year-olds? On yearlings? On calves?*

63. *What average daily gain do you get when full feeding on grass on two-year-olds? On yearlings? On calves?*

64. *What gain do you get when carrying stockers through the winter without grain?*

65. *Does feeding grain to stockers in winter diminish summer gains on pasture?*

66. *What gain do you get on pasture without grain for the season? (Six months).*

67. *Do steers gain as much toward the close of the feeding period as in the beginning?*

68. *Do you sell your cattle to local butchers, traders, or do you ship them yourself?*

69. *Where do you market your fat cattle?*

70. *What month do you sell?*

71. *At what age do you sell? At what weight?*

72. *How much does a steer shrink from feed lot to market?*

73. *What do your cattle grade on the market?*

74. *What treatment do you give your steers the last two or three days before shipment?*

75. *What do you use for bedding cars?*

76. *Do you accompany your cattle to market?*

FINANCIAL.

77. *What margin between the cost of feeders and the selling price of steers is necessary to break even?*

78. *What is the cost of a pound of gain in summer?*

79. *What is the cost of producing a calf until weaning time?*

80. *What is the cost of producing a one year-old feeder?*

81. *What does it cost to produce a two-year-old feeder?*

82. *Do you buy commercial fertilizer?*

83. *What do you consider as the value of the manure from a fattening steer?*

84. *What is the land worth per acre in your community?*

85. *Is your land increasing or decreasing in fertility?*

SALT.

86. *What kind of salt do you use?*

87. *How often do you salt your cattle?*

88. *Will cattle getting clover hay eat more salt than when getting timothy?*

HOGS.

89. *Do you find beef cattle profitable unless you consider the hogs in connection with them ?*

90. *How many hogs do you use per steer on full feed where no additional feed is fed to hogs ?*

91. *What do you consider the best age to turn a pig into the feed lot ?*

92. *What weight do you prefer to have them when turned into the feed lot ?*

93. *What breed do you prefer ?*

94. *Where do you obtain your hogs ?*

95. *What gain do you get on your hogs ?*

96. *Do you feed any additional feed ?*

97. *Have you found cotton seed meal fed to cattle injurious to hogs following ? Have you found linseed meal fed to cattle beneficial to hogs following ?*

MISCELLANEOUS.

98. *What is the most important problem before the cattle feeders at present ?*

99. *What information in regard to the methods of feeding would enable feeders to handle cattle more profitably ?*

100. *Please state the average selling price on the farm, and the feeding value of the following feeds :—*

Corn, bushel.
Oats, bushel.
Clover hay (loose) ton.
Timothy hay (loose) ton.
Oat straw (loose) ton.
Wheat straw (loose) ton.
Corn fodder, shock.
Stalk field, acre.
Sheaf oats, bundle.
Millet, ton.

DISTRIBUTION OF REPLIES ACCORDING TO COUNTIES.

County.	No. lists sent out.	No. replies received.	County.	No. lists sent out.	No. replies received.
Adams	13	12	Lawrence	24	15
Allen	16	6	Madison	57	33
Bartholomew	17	10	Marion	51	21
Benton	42	35	Marshall	18	8
Blackford	9	5	Martin	18	11
Boone	48	32	Miami	46	24
Brown	5	--	Monroe	19	2
Carroll	31	12	Montgomery	70	28
Cass	19	14	Morgan	33	9
Clark	5	5	Newton	28	14
Clay	10	7	Noble	8	5
Clinton	19	12	Ohio	26	4
Crawford	14	2	Orange	24	11
Daviess	49	17	Owen	5	1
Dearborn	5	2	Parke	36	13
Decatur	15	12	Perry	10	7
DeKalb	8	4	Pike	24	8
Delaware	75	21	Porter	25	5
Dubois	3	1	Posey	45	9
Elkhart	11	7	Pulaski	22	8
Fayette	12	4	Putnam	77	20
Fountain	34	16	Randolph	42	14
Franklin	14	6	Ripley	6	--
Fulton	12	3	Rush	101	25
Grant	54	19	Scott	22	11
Gibson	7	3	Spencer	2	1
Greene	16	7	Shelby	39	10
Hamilton	45	21	St. Joseph	10	4
Hancock	32	11	Starke	9	4
Harrison	22	5	Steuben	31	9
Hendricks	99	30	Sullivan	10	7
Henry	45	17	Switzerland	6	4
Howard	5	3	Tippecanoe	17	7
Huntington	24	6	Tipton	53	20
Jackson	44	11	Union	32	11
Jasper	47	11	Vermillion	18	9
Jay	28	13	Vigo	25	6
Jefferson	36	14	Wabash	22	4
Jennings	3	3	Warren	58	14
Johnson	23	7	Warrick	20	8
Knox	39	8	Washington	6	4
Kosciusko	27	8	Wayne	43	17
LaGrange	21	6	Wells	36	4
Lake	19	8	White	45	10
LaPorte	12	7	Whitley	30	11

Total number questions sent out 2486
Total number replies received 929

After making a study of the replies to the questions, which were

sent out primarily for the purpose of securing information which would enable the Animal Husbandry Department to more intelligently conduct experiments in cattle feeding, it is thought that the data from so wide a range of practical experience are of sufficient interest and importance to Indiana feeders to justify the Experiment Station in publishing the report.

THE EXTENT OF THE BUSINESS.

The first five questions were relative to the extent of the business of cattle feeding in Indiana. The first two questions indicate that the reports are based upon the feeding of 806,862 steers. The average experience of each man extended over 18.3 years involving the use of 55.5 steers annually. On January 1st, 1906, there were in Indiana 1,141,778 cattle other than milk cows. It would be fair to assume that not more than one-fourth of these were in the feed lots being finished for market. From these figures the conclusion may be drawn that the replies to this list of questions are based upon the feeding of three times as many cattle as were fed in the whole state during the year 1906, hence the report should, in a measure, be authoritative as it is not only given by men who have had a long practical experience, but who have handled cattle in sufficient numbers to justify them in reaching conclusions, based upon their own experience. Such information should prove valuable to others engaged in the same line of work.

For the year 1906, 31 per cent reported an increase in the number of cattle being fed in their locality, 15 per cent reported no change, while 54 per cent reported a decrease. The majority, or 63 per cent of these same men reported that they, themselves were feeding more cattle than was their usual custom, while 37 per cent reported a decrease in the number they were feeding. This is an interesting fact in that the men reporting were, as a rule, experienced feeders who had fed cattle for many years. This means that the professional cattle feeder is more apt to increase his holdings of cattle at a time when the average number of cattle going on feed is smaller than usual, while the man who feeds only a car load occasionally is apt to drop out of the market just at the time it should prove a profitable proposition.

BEEF PRODUCTION ADAPTED TO LARGE FARMS.

The average size of the farm devoted to beef production in Indiana as reported in answer to question 5, was found to be 398.3 acres, of which 98 acres is in corn, 135 in pasture and 60 in meadow. This shows that 75 per cent of the total area of the farms reported

is in corn and grass, leaving the other 25 per cent to buildings, lots, orchards, gardens, woodland and the growing of small grains which would indicate that the extensive corn grower has found it impossible to keep up soil fertility without the use of livestock. The labor problem precludes the possibility of marketing so great a quantity of corn through dairy cattle, and as hogs are not adapted to utilize the roughage in a satisfactory way, the producer must either feed beef cattle (or other meat-making animals) or market his grain at the elevator. The cost of feeding corn to cattle is no greater than the cost of hauling it to market while the amount of time actually consumed is not materially greater. In other words, the labor involved in feeding beef cattle may be fairly charged against the cost of marketing farm crops rather than against the profit in feeding cattle. A further feature in regard to the labor in feeding beef cattle is that it gives employment throughout the entire year.

BEEF FARMS ARE LARGELY DEVOTED TO CORN AND GRASS.

Under average conditions in the state, the farms devoted to the production of beef contain 1.76 acres of corn and 2.42 acres of grass for every steer marketed during the year. This does not mean that this amount of land is devoted exclusively to steer feeding. A part of the corn would necessarily be fed to hogs, to teams on the farm, to breeding cows, young cattle and stockers that are being carried over the winter; and doubtless a limited amount would be sold on the market. The amount of grass, as will be seen on page 20 of this report, in reply to question 41, is more than is necessary for full feeding cattle on grass. For this reason it is supposed that a large number of cattle feeders carry upon their farms a bunch of steers, as stockers, without giving them any great amount of grain; thus having on hand in reality two distinct classes of cattle; one in the feed lot, being finished for market; the other in stocker or feeder condition, being prepared for the feed lot at a later date.

Assuming that corn would yield 50 bushels per acre, which is ten bushels more than the average for the state, the average cattle feeder would produce 4400 bushels of corn annually. It is estimated that 50 bushels of corn is sufficient to fatten a steer; this will leave 1650 bushels of corn over and above what is necessary to finish 55 cattle, which may be used for other purposes.

LEGUMES APPRECIATED BY CATTLE FEEDERS.

Practically every cattle feeder in the state reported that he was growing clover. Alfalfa is being grown by 22 per cent; cow peas by 8 per cent and sorghum by 15 per cent of those reporting.

The replies to this question indicate that reports were made by the most progressive farmers of the state, as these crops are being produced only by those who are thoroughly informed in regard to the best agricultural practice. The answers to question 9 indicate that the cattle feeder is endeavoring to make a larger use, than is generally supposed, of leguminous crops, such as clover, alfalfa and cow peas, and of supplements to pasture, such as sorghum.

SHELTER FOR FATTENING STEERS.

Under question 10 there was a great variety of answers given. A number reported the use of two or more kinds of shelter such as barn and straw stack, or barn and open shed. Taking a summary of all answers, it was found that 609 are using barns; 302 open sheds; 357 straw stacks; 177 timber lands and 268 are using open lots for feeding cattle. In most instances where timber or open lots were reported it was found that they were usually used in connection with either a barn or open shed. That is, there are very few feeders who do not favor some form of shelter for cattle. The importance of a dry shed and a windbreak is thoroughly appreciated. Seven per cent of the men are making some provisions against flies in summer and 93 per cent are paying no attention to this matter, whatever. This is in accordance with the generally accepted view that, to date there is no cheap, economical method of effectually combating the nuisance of flies. Those who do report some provision for this purpose are in the main depending upon a darkened barn to which the cattle have access during the heat of the day. This is usually secured by hanging burlap curtains over the doors and windows and letting just as little light in the barn as possible.

FAVORABLE CONDITIONS IN FEED LOTS ADVANTAGEOUS.

Muddy feed lots are the source of much inconvenience in the state. Seventy-seven per cent make no provision whatever against mud; 23 per cent use various sorts of paving materials, bedding the whole lot very deeply with straw, or feeding in some place, such as a sand ridge, where lots never become muddy. Where cattle are confined to a small lot, it has been found that the mud nuisance can be avoided very readily. This however, necessitates the use of a large amount of straw which is not always available to the professional feeder. The cattle which are in barns or covered lots are not at so great a disadvantage and the amount of straw necessary to keep them out of the mud is not nearly so great. The answers to question 12, "Do your cattle get lousy in winter?" show that

83 per cent report no trouble from this pest; some trouble is reported by 17 per cent. Of those who are bothered in this way, 33 per cent report the use of coal tar disinfectant or dip, for ridding their cattle of lice. The use of home made preparations is reported by 55 per cent. The other 12 per cent make no provision whatever to exterminate them.

ADEQUATE SUPPLY OF PURE WATER NECESSARY.

Wells for the purpose of watering cattle are reported by 58 per cent of the feeders. Springs are available to 21 per cent and the remainder depend upon ditches, creeks or natural ponds. This shows that a large majority of cattle feeders appreciate the value of a good source of pure water. Tank heaters are being used by 30 per cent of the feeders who practice winter feeding. A few of the remainder depend upon pumping water just as the cattle need it; upon springs which never freeze up, or upon banking the water tanks with saw dust, manure or some other substance to keep them from freezing, but, taken as a whole, the great majority make no provision whatever in regard to warming the water in winter.

RAISING AND BUYING FEEDERS.

In reporting upon the question of raising or buying feeders, it is found that 42 per cent of the cattle feeders do not pretend to produce any of their cattle; 52 per cent grow part of them and buy the remainder, while only 6 per cent are really beef producers, that is, breeding their own cattle and feeding them out. This agrees with the generally accepted view that the cattle feeder is not, as a rule, a cattle producer, or stating it in another way, the cattle producer does not finish his own product. There seem to be two distinct classes of men engaged in the business; one class devoted to the production of feeders whose problem is to grow them as cheaply as possible without the use of concentrated feeds, in order to market a large amount of grass and cheap, rough feeds in proportion to grain; and the other class devoted solely to the fattening of cattle, buying feeders as cheaply as possible and using them chiefly to market a large amount of corn in proportion to other feeds.

BETTER CATTLE CAN BE PRODUCED THAN BOUGHT.

It is generally accepted that the advantages in growing feeders are that the cattle are better in quality and breeding, are more quiet, and make better gains. Twelve per cent of the answers indicate that cattle can be produced cheaper than they can be bought, considering grade and quality, but the greatest advantage in

growing cattle is that they are better. The man who produces a high grade beef steer, does not do so by accident, but because he has given time and attention to his business, studied market demands and observed the type of cattle which make cheap, rapid gains in the feed lot and finish into the most desirable market product. When he has produced these cattle and compares them with such as must be purchased as feeders, he finds them more satisfactory as they have the capacity and the constitution to stand heavy feeding without getting "off feed", are blocky, compact animals which require a relatively short feed to finish and are of a quality which secures top prices.

Of those who are producing a part of their cattle, 82 per cent allow the calves to suckle the cows, while 18 per cent milk the cows and grow the calves on skim milk. Stating it in other words, the general practice of the men who grow feeders, is to depend solely upon the calf to pay for maintaining the cow a year. This necessitates the use of improved blood which is also evident by the answers to the preceding question where 83 per cent of those reporting, state that the cattle are better. Seventy-five per cent of those who are raising their own feeders, feed the calf grain before weaning.

CATTLE FEEDERS DO NOT RAISE THEIR OWN CATTLE.

In regard to purchasing feeders, 94 per cent of the men purchase at least a part of their feeders. This means either that the cattle feeder has not the facilities for producing a sufficient number of cattle, or that he feels that they can be produced cheaper in other localities not adapted to the growing of corn. Of those who buy their feeders, 29 per cent go to Chicago for them; 27 per cent buy in their immediate locality; 15 per cent in Indianapolis; 9 per cent in Kansas City and the remainder are purchased in various places, showing that the general practice of the feeder buyer is to go to some central market when he is unable to obtain the cattle in his immediate locality.* During the past three years the Station has found that feeders can be purchased during the fall of the year in the southern part of the state at a price which will justify feeding them out. These cattle possess constitution and capacity, with a fair degree of beef type and are capable of making rapid and economical gains. They do not have the best quality and breeding, but have a tendency to be plain and leggy. Otherwise they are all that can be desired in feeding cattle.

*See Circular No. 8, "Purchasing Feeders", Purdue Experiment Station.

THE ADVANTAGE OF PURCHASING FEEDERS OVER RAISING THEM.

Fifty-eight per cent report that their reason for buying feeders is that they can be bought cheaper than they can be produced under conditions which are now confronting them. Twenty-five per cent report that they can get more uniformity; 12 per cent report that they can obtain better selection. The other reasons for purchasing are as follows: "A greater number can be handled", "quicker returns secured", "less trouble in buying than in raising cattle"; but the preponderance of evidence is that two-year-old steers can be purchased cheaper than they can be raised. This does not hold true of the calf which will, on the average, bring 5 cents per pound in the fall of the year after running with his dam throughout the summer and will weigh at that time between 450 and 600 pounds. This is only possible however, where bulls of the best beef blood are used on cows possessing at least a fair degree of beef type. Fifty-one per cent of the feeder buyers buy cattle in the fall of the year; 16 per cent in the spring, and the remainder during the summer and winter. This would seem to indicate that the practice of winter feeding is more extensive than summer feeding, as cattle are, in a great majority of cases, put on full feed immediately after being purchased.

FEEDERS PREFER TWO-YEAR-OLD STEERS.

In regard to the age at which steers are purchased, 76 per cent of those reporting, prefer to buy two-year-old steers; 16 per cent yearlings, and only 7 per cent prefer calves. The average weight of the most desirable two-year-old steer is in the neighborhood of 1000 pounds. He should also be what is termed a "fleshy feeder", if to be placed on grain feed immediately. Another question which bears directly on the age of cattle used in the feed lot was asked, "Do you feed steers three-years-old or over? If so, why?" It was found that 18 per cent express a preference for them. The main reasons given were, they usually carry more flesh, make more rapid gains, fatten quicker, thus shortening the feeding period, require less grain to finish them, utilize rougher and coarser feeds, feed out more uniformily, withstand severe weather better, and at certain seasons of the year sell better. Another reason given by two men, and probably of as great importance as the preceding, was that a coarser and plainer class of cattle could be used than where younger steers were fed. It would seem that just so long as steers weighing from 1000 pounds to 1250 pounds can be bought low enough to insure a profit in feeding them out with a short, quick heavy grain feed, they will be preferred by extensive cattle feeders. Fleshy

feeders are preferred because they can be returned to market in a shorter time, thus allowing the corn grower to put in cattle in the fall of the year, after the busy crop season is over, feed them during the winter months and return them to market before spring work demands all of his time.

BABY BEEF.

Question 22 was asked in order to obtain information in regard to the extent of the production of "baby" or yearling beef. A summary of all answers given indicates that 25 per cent of the men reporting were at that time engaged in producing yearling beef and 75 per cent in feeding older cattle. The feeder who buys calves with the intention of making yearling beef, must of necessity demand more quality, better breeding and expect to feed them on a better quality of feed than is necessary in handling older cattle. It takes from 8 to 10 months to make them fat enough to sell well, and the profits depend upon the cheapness of gains. This method should appeal especially to the man who is raising calves and finishing them as he would market them at 15 to 18 months of age, and if of proper breeding and sufficiently finished, would usually secure nearly as high a price per pound as for older cattle. The feeder who intends to produce "baby" or yearling beef, requires that the calves be carrying their milk fat when started on feed, as it is impossible to fatten a calf as a yearling, which has lost the calf fat before started on a full feed of grain. Stating it differently, it is absolutely necessary that typical, blocky beef calves carrying their milk fat, be used if any profit is to result in the production of yearling beef.

PREPARATION OF FEEDS.

The question of whether or not it is profitable to put a large amount of labor on corn to increase the feeding value, is one that is very largely disputed. There were 73 per cent of the feeders who reported the use of broken ear corn, which is about the simplest form in which it can be fed; the next in rank of popularity was feeding shock corn which is used by 46 per cent of the feeders; the next is snapped corn used by 35 per cent; corn and cob meal seems to be next in favor with 27 per cent using it; shelled corn is used by 21 per cent. Other methods of preparation such as soaking or grinding are not very extensively used. About 4 per cent of all who answered this question are soaking their corn and 4 per cent are feeding it in the form of corn meal. This would seem to indicate that the most profitable method is to feed it as broken ear or

snapped corn which logically follows with the preference of the feeders for two-year-old cattle. The answers indicate that by far the greater per cent prefer to feed their corn with as little labor in the preparation as possible. In other words, they think that the increased returns due to grinding, soaking, or shelling, are not sufficient to offset the labor in the operation.

OATS AS A CATTLE FEED.

In regard to feeding oats to fattening steers, 60 per cent of the cattle feeders do not use them at any time during the feeding period. For special purposes, such as starting steers on feed, or finishing them during the last month, 25 per cent use them. Others feed oats to calves and young stock only, leaving a small per cent who feed them at all times and to all ages and classes of cattle. This is what would naturally be expected from the relatively high price oats demand on the market as compared with corn and other concentrated grain feeds.

THE USE OF SUPPLEMENTAL FEEDS.

The use of supplemental feeds such as bran, linseed meal, cotton seed meal and gluten feed seems to be quite extensive and growing in popularity. Forty per cent of those who use supplemental feeds prefer bran. This certainly is not due to any superior feeding value which bran has over other supplements, but rather to the fact that it is a safe feed with which feeders are familiar, is available in almost any locality and is thus the most easily obtainable of all supplemental feeds. Linseed meal, which is used by 44 per cent of the feeders, seems to be the most popular of all commercial concentrated feeds; cotton seed meal by 9 per cent and gluten feed by less than 4 per cent. It was noted that not more than 50 per cent of all the men engaged in cattle feeding make any use of supplements, while of those who do appreciate their value, less than 10 per cent use them continually from the beginning to the end of the feeding period. In the great majority of instances, they are used for the same purpose as oats, to stimulate the appetite toward the close of a long feeding period or during the last four to six weeks to give a "finish" or "bloom" to the cattle. The amount fed varies from a "handful per steer daily" up to as high as 8 pounds, which is reported by one feeder. There seems to be no general rule followed as to the amount which should be fed in order to secure the greatest returns even by those who are most thoroughly familiar with such feeds. The work of the Animal Husbandry Department of Purdue Experiment Station indicates that the value of such feeds

is even greater than is generally believed by the most progressive feeders.[1]

CLOVER HAY ROUGHAGE MOST EXTENSIVELY USED.

Clover hay seems to stand in a class by itself as a roughage to feed with corn for fattening cattle. Practically all who reported, use clover hay where it is available, and in the majority of cases, they prefer it to any other roughage. The next feed in popularity is corn stover, which is fed by nearly everyone who feeds cattle. An interesting feature in this connection is that three times as many prefer clover to timothy hay. The cattle feeding experiment conducted during the winter of 1906-07 proved conclusively that it is impractical to use timothy hay as a roughage for cattle if it is possible to get clover.

METHODS OF UTILIZING CORN STALKS.

Corn stalks are recognized as a necessary adjunct to the production of corn. The experimental work of the Agronomy Department has shown that practically one-half of the weight of the corn crop is found in the ears and one-half in the stalk. It is also true that 37 per cent of the digestible nutrients of the corn crop, grown for grain, is in the stover and 63 per cent in the ears.[2] The question of handling stalks, so that the cost of labor employed in cutting, storing and curing them into a palatable form of roughage, will not overbalance their feeding value, is one of immense concern to the farmers of the state. It seems a large waste to allow one-half of the weight of the corn crop to stand in the field and be pastured off during the late fall and early winter months. In summarizing the answers to this question, it is found that 424 practice this method as compared with 495 who cut their corn. Of those who shock their corn, 64 per cent also shred it. As this does not increase the feeding value of the material the benefit comes from convenience in storing and feeding and from decreasing the amount of labor necessary in handling the manure.

SILAGE AS A FACTOR IN BEEF PRODUCTION.

The question of whether or not it is profitable to use corn silage in fattening cattle, is one that is being considered very carefully by cattle feeders all over the corn belt. Seven per cent of the beef cattle feeders in Indiana are using silage. A more careful study of this question shows that practically all of them are using corn as

1 See Bulletin 115, "Steer Feeding", Purdue Experiment Station.
2 See Henry's "Feeds and Feeding", p. 169.

the chief crop for making silage. Other crops such as alfalfa, sorghum, oats, milo maize and fodder are mentioned but not used in an extensive way. It would seem from these reports that corn is the most satisfactory crop for the silo. This is because the other crops mentioned, if properly handled, are almost wholly consumed by cattle without putting them in a silo. In feeding shock corn or corn stalks in any form, there is from 20 to 50 per cent of the stalk refused by all farm animals. When properly made into silage this is put into such a mechanical condition and made so palatable that it is consumed with very little waste.

ADVANTAGES IN FEEDING SILAGE.

As the practice of feeding silage is comparatively new among cattle feeders, the information obtained in the reports by those using it should carry a great deal of weight. There is probably no better way of presenting their views than to give a few concise quotations from practical feeders.

" Advantages :

1. Conserve highest possible value of crop.
2. Work done in long days, etc.
3. No waste of feed.
4. Capacity of farm more than doubled.
5. Land not injured by hauling.
6. Clean ground for other crops.
7. Most economical way of handling corn crop.

Disadvantages :

1. Additional expense for machinery and silo.
2. Crop must be fed to ruminants.
3. Extra labor required at filling.
4. Silage not diversified nor marketable ".

" Advantages :

1. Economy of storing feed.
2. Small expense in feeding.
3. Supply of succulent feed on which cattle do well.

Disadvantages :

1. Expense of silo and machinery for filling ".

" Advantages :

1. Cheapens the feed.
2. Makes perfect digestion.
3. Convenient, is liked by animals.
4. Enables you to feed ground feed to advantage.

Disadvantage:

1. Cattle drift more when shipped".

"Advantages:

1. Succulent feed in winter.
2. Convenient to feed, less waste.
3. Get crop in better time and cheaper.

Disadvantage:

1. Less corn to feed whole".

"Advantages:

1. Too many to enumerate.

Disadvantage:

1. Hogs won't do as well after cattle".

Miscellaneous replies:

"Cheaper than pasture and fully as good but takes more time".

"Feed always handy and in the dry. Do not have to expose yourself".

"Best and most economical way of supplying filling".

"Utilize more of the plant in silage. Convenient to mix other feeds with. Handy to feed".

"Sharpens appetite. Helps balance ration".

"All advantages. Only disadvantage is that when grain is increased, silage makes the bowels too loose".

"Cattle consume entire corn plant. Keeps cattle in good condition".

"Convenient, no waste. Never saw cattle off feed".

"Cheap feed and keeps cattle in fine condition".

"Silage easy to feed. Are working to find disadvantages".

"No disadvantages. Cheapest feed available. Keeps stock thrifty and hearty".

"No disadvantages except mud around the silo".

"Easy to feed and get full benefit of entire corn field".

"Improves digestion, stimulates appetite and gives better appearance to skin and hair".

"Appetizer. Keeps bowels loose, grain in better shape to be digested. More feed can be put in same space".

SUMMARY OF ADVANTAGES.

1. Work done in long days, etc.
2. No waste of feed.
3. Capacity of farm more than doubled.
4. Land not injured by hauling.
5. Clean ground for other crops.
6. Most economical way of handling corn crop.
7. Economy of storing feed.
8. Small expense in feeding.
9. Supply of succulent feed on which cattle do well.
10. Cheapens the feed.
11. Makes perfect digestion.
12. Convenient, is liked by animals.
13. Enables you to feed ground feed to advantage.
14. Cheaper than pasture and fully as good but takes more time.
15. Do not have to expose yourself. Feed always handy and in the dry.
16. Cattle consume entire corn plant. Keeps cattle in good condition.
17. Improves digestion, stimulates appetite and gives better appearance to skin and hair.

SUMMARY OF DISADVANTAGES.

1. Additional expense for machinery and silo.
2. Crop must be fed to ruminants.
3. Extra labor required at filling.
4. Silage not diversified nor marketable.
5. Cattle drift more when shipped.
6. Less corn to feed whole.
7. Hogs won't do as well after cattle.
8. No disadvantages except mud around the silo.

These few reports cover in a thorough manner all of the advantages and disadvantages mentioned by the feeders who are at present using silage. There are other factors entering into the use

of this feed which have been observed in the feed lots at the Station, but have not been touched upon by those reporting.

THE USE OF CONCENTRATES WITH SILAGE.

In answer to question 59, it was found that 90 per cent of the feeders using corn silage depend upon corn as the main part of the grain ration. Ten per cent are feeding either cotton seed or linseed meal in addition to other grain with silage. This, according to the results secured at Purdue Experiment Station in the winter of 1906-07 would indicate that the advantage of feeding a concentrated nitrogenous feed with a ration composed of corn and corn silage, is not generally appreciated as much as it should be. It was found in that experiment that the addition of cotton seed meal to such a ration resulted in an increase in value of 6 cents per bushel on corn fed over and above the cost of concentrated feed. In other words, it proved to be a highly profitable investment to feed a limited amount of cotton seed meal with a ration composed of shelled corn, corn silage and clover.

PASTURE PRODUCES CHEAP AND ECONOMICAL GAINS.

Blue grass seems to be the favorite for grazing purposes, followed very closely by clover, mixed grasses and timothy, in the order named. In answer to question 41, "How much pasture is required per steer when on full feed of grain?" the average number of acres given is 1.1. The average number given when the steers are not receiving grain is 2 acres, showing that summer feeding of cattle permits a more intensive system of agriculture than grazing in summer and feeding in winter. Practically twice the amount of grass is necessary where steers are grazed without grain as where steers are grazed and given a full feed of grain. In regard to the time of turning out on pasture, 70 per cent do so early in the spring and 30 per cent keep their cattle up until the grass has attained some degree of maturity and lost its washy nature. This is probably contrary to the best practice, so far as the most economical use of pasture is concerned but may be justified on account of the additional expense and labor in feeding in dry lot.

WINTERING STOCKERS AND FEEDERS.

Of those who are carrying their stockers through the winter, 77 per cent feed nothing but roughage. Only 23 per cent feed grain in any form and of these the majority feed late in the spring just before turning out on grass. This would indicate that stockers are purchased in the fall, not with the view of increasing their weight

during the winter, but rather for the purpose of securing them more cheaply, returning the plant food contained in rough feeds, such as corn stalks, straw and hay to the soil and having cattle of such quality and in such condition as to insure maximum gains on grass.

WINTER VS. SUMMER FEEDING.

Question 46 deals with the general practice of winter and summer feeding. Replies indicate that 60 per cent of the feeding in Indiana is done in the winter; 40 per cent in the summer. This is what would naturally be inferred from the answers to question 26, in reply to which 51 per cent preferred to buy feeders in the fall and 16 per cent in the spring. From this it would appear that the majority of cattle feeders put their cattle on feed immediately after purchasing, while the minority prefer to buy thin or stocker steers, use them for consuming roughage on the farm, and feed them out at a later date.

WINTER FEEDING PROFITABLE IN INDIANA.

Forty-one per cent report winter feeding as most profitable; 33 per cent, summer; 16 per cent, spring; and 10 per cent, fall. In other words, the great majority of cattle feeders are either feeding in summer or winter. The particular system followed depends largely upon the facilities within reach of the individual. When there is a large amount of cheap grass land, the practice seems to be in favor of summer feeding; where all of the land is adapted to the production of corn and small grains, it would seem that winter feeding is most general. This carries out the thought in the first paragraph of this circular, in which it was stated that the business of cattle feeding is one of disposing of farm crops. In winter feeding 86 per cent use a small lot for their cattle and 14 per cent allow access to pasture, which has not been used heavily during the summer. There is no accurate information upon this subject but so great a showing in favor of the small lot should be given due consideration.

TURNING FULL FED STEERS ON GRASS.

Where steers have been full fed on grain during the winter with the intention of marketing them during the early summer month the question arises as to whether they should be turned on grass in the spring with a full feed of grain, or be kept in a dry lot until finished. The replies to question 50 show that the great majority prefer to finish in a dry lot. The reason for this is that steers which have had a full feed during the winter, and then turned out on a good pasture, do not consume a sufficient amount of grain at first,

but depend too much upon grass which has less substance and is more palatable. The result is that they shrink rapidly in weight for the first 10 to 15 days, so that they weigh little if any more, a month later than when turned out. After that, however, they will make more rapid gains than if they had been in a dry lot. When marketed, the buyer prefers "dry fed" to "grassy" steers as they dress out a higher percentage of carcass to live weight and also yield firmer meat. If, owing to the high price of roughage, or some other equally good reason, it is necessary to turn such cattle on grass, then it is probably advisable to do so as soon as the ground becomes firm enough in the spring to prevent injury from tramping and to continue to feed roughage in addition. In this way the cattle and the grass come on together so that there will be no abrupt change in the feeding which would result in a corresponding period of loss on the cattle.

METHODS OF FEEDING.

The time consumed in getting cattle on full feed by different feeders varies from three days to three months. The average of all replies to this question is 34 days. The length of the period for feeding a full feed depends largely upon the age and condition of the steers when put in the feed lot, the degree of finish attained and the kind of feed used. The answers to question 51 would indicate that 70 per cent practice feeding through a long, and 30 per cent, through a short period. In summarizing the answers to this question, all who prefer feeding 100 days or less were classified in the short feeding list. The average length of feeding full feed under all conditions is 131 days, which with 34 days consumed in reaching a full feed, would make the average length of the whole feeding period 165 days.

USE OF SELF-FEEDER.

The self-feeder seems to be more in general use during the summer than winter. By this method, cattle can be fed once or twice per week rather than per day and the labor involved is very much less. After cattle are on full feed the self-feeder is satisfactory, provided the proper amount of attention is given to it. It has been the experience of a number of feeders, however, that practically as much time is consumed in keeping the feeder working properly as would be in feeding at regular intervals. In the use of the self-feeder, special care and attention are necessary to avoid clogging in the feeder, as it is important that there be an abundance of feed available at all times. Provision must also be made for protecting the grain, as dampness, together with high temperature, causes fermentation, especially with ground feeds such as linseed or

cotton seed meal or bran. If allowed access to this sour or fermented feed, the cattle are very apt to be troubled with indigestion. All of these details necessitate great care when self-feeders are used successfully.

ROUGHAGE USUALLY FED IN UNLIMITED QUANTITIES.

The evidence is that roughage is usually fed in unlimited quantities, less than 12 per cent indicating that they make any pretention to the use of a limited amount. The usual custom is to keep the racks full at all times so that the steers are able to select out the more palatable portions and refuse the remainder. The work of the Station would indicate that fully as good results may be secured by limiting the amount of roughage to what the cattle will consume without waste. This is especially true in seasons like that of 1906-07 when roughage was actually worth more per pound than grain. The replies to question 60, show that 91 per cent of the feeders make no effort to have the roughage and grain in such condition that both will be consumed at the same time. This is in line with other statements in regard to the cost of producing beef and shows conclusively that the average cattle feeder firmly believes in the practice of feeding his farm products in such a way as to avoid labor. That is, he believes that the additional expense due to chaffing hay and mixing it with grain would not be balanced by the difference in the efficiency of the ration.

GRAIN CONSUMED BY STEERS ON FULL FEED.

The reports indicate that the average amount of grain considered a full feed per head daily for two-year-old cattle is 22.8 pounds; for yearlings, 15.6 lbs; and for calves, 4.3 lbs. The amount given for two-year-olds and yearlings is approximately correct as these figures compare very favorably with results at the Station. It would seem, however, that feeders have underestimated the amount consumed by calves as that reported is small as compared with the data obtained from the experimental lots at the Station for the past two years, which was from 9 to 10 lbs. daily per calf when on full feed.

GAINS MORE EXPENSIVE IN WINTER THAN IN SUMMER.

In reporting on question 57, it was found that twice as many men reported on the amount of grain required per pound of gain on two-year-old cattle as on yearlings and three times as many report on two-year-olds as on calves. This is consistent with the answers to the former question in regard to the age of cattle preferred in the feed lot, and shows that as yet, the great majority of cattle feeders prefer cattle carrying some age. The average of all answers to the

question "How much grain is necessary per pound gain in summer for two-year-olds on full feed? for yearlings? for calves?" is that 9.2 pounds of grain are consumed per pound of gain on two-year-old cattle; 7.5 pounds on yearlings and 5.6 pounds on calves, to produce one pound of gain; to the question "How many pounds of grain does it take per pound of gain in winter for two-year-olds on full feed? for yearlings? for calves?" is that 11.2 pounds of grain are consumed per pound of gain on two-year olds; 8.9 on yearlings and 7.7 on calves.

It is interesting to compare the replies to these two questions which show that the gains are more expensive in winter than in summer feeding. From the reports, feeders estimate that it requires two pounds more on the two-year-old; 1.4 pounds more on the yearlings and 1.1 pound more on the calf to produce a pound of gain in winter than in summer. This is consistent with the figures in experiments at Purdue and other experiment stations.

COST OF GAIN INCREASES WITH AGE OF CATTLE.

While these reports are not based upon accurate records but rather upon estimates made by practical feeders, they indicate that cattle feeders generally agree that the cost of gains increases with the age of the cattle as the two-year-old steer makes his gain at a greater cost of feed than either the yearling or the calf because the ability to consume grain increases more rapidly than the rate of gain. The difference in the cost of gains on two-year-olds, yearlings and calves, is not so great as is generally conceded by the men who are producing yearling beef, as it is frequently stated that the cost of gains on two-year-old steers is from two to three times as great as it would be on calves. The evidence here presented would indicate that such a statement is greatly exaggerated. Another important point, and one which is frequently overlooked by cattle feeders, in considering the cost of gains, is that practically twice as much gain must be put on calves to make them prime, as is necessary to finish two-year-old steers starting in the feed lot in equal condition.

GAINS SECURED UNDER DIFFERENT METHODS OF FEEDING.

In answer to question 62 as to the average daily gain for full feeding in winter, the reports show that two-year-old cattle gain 2.1 pounds per day; yearlings, 1.9; calves 1.7. In summer two-year-olds gain 2.7; yearlings 2.3 and calves 2.3. These figures on the winter feeding of cattle are comparable with the results obtained at the Experiment Station where it was found that the daily gain varies almost directly with the age of the cattle; that is, the older the

steer, the greater is the daily gain while in the feed lot. It is interesting to note that in summer the average daily gain on yearlings and on calves is given at the same figure. The report also shows that the daily gain per steer is greater during the summer when full feeding than during the winter. This is consistent with the answers to questions 57 and 58 and in a large measure accounts for the difference in the cost of producing the gains on cattle of different ages.

METHOD OF WINTERING INFLUENCES GAINS IN FOLLOWING SUMMER.

In answer to question 65 "Does the feeding of grain to stockers in winter diminish gains in summer on pasture?" 85 per cent report that it does not, while 14 per cent report that it does and about 1 per cent are undecided as to this question. When it is stated that the feeding of grain does not diminish summer gains, a great majority qualify this statement by saying "if not fed in excessive quantities". In other words, the general practice is to feed a small amount of grain in order to keep steers from losing flesh and running down to a condition from which they will not recover quickly when put on pasture in the spring. It seems to be a question of how much grain is fed rather than as to the feeding of grain. None of the feeders prefer to have their steers go on grass in high condition if they expect to graze without feeding grain.

SMALL GAINS ON STOCKERS IN WINTER.

The average of all answers to question 64 would indicate that if the steers maintain their weight during the winter period where no grain or other concentrated feed is used, their condition is satisfactory. In other words, the practice of roughing stock through the winter is not for the purpose of making any gain on them but for one or both of the following reasons: (1) to utilize and return to the land in the form of manure, the rough feeds such as corn stalks, straw, damaged hay, which would otherwise go to waste; (2) to have cattle in the spring of the year of suitable quality and condition to make rapid gains on grass. The feeder who has an abundance of rough feed is usually able to buy thin cattle in the fall, carry them through the winter very cheaply, so that the cost of the cattle and the cost of wintering them will amount to less than he would have to pay for the same cattle in the spring. It is further agreed that the steer so handled during the winter goes on grass in a condition to insure a maximum gain during the summer. A careful study of market reports will convince one that stocker and feeder cattle carrying flesh, are much cheaper during the late fall than during the spring months.

GAINS MADE ON GRASS WITHOUT GRAIN.

The gains secured on steers during the grazing season (6 months) without grain is, on an average, 301 lbs. or approximately 50 pounds per month. As pasture costs from 75 cents to $1.00 per month, it will be seen that the cost of gains in summer on grass alone, amounts to from 1¾ to 2 cents per pound. This question may be reduced to a problem which confronts the cattle feeder as follows: a thin stocker weighing 750 pounds in the spring when grazing season begins, worth 5 cents per pound, with pasture at the ordinary price of $1.00 per month, and having made a gain of 300 pounds, can be sold in the fall at $4 15 per hundred without either gain or loss in the transaction. This largely accounts for the fact that feeders can be bought cheaper in the fall than in the following spring.

PREPARATION OF CATTLE FOR SHIPMENT.

In regard to the treatment of cattle before shipment, 52 per cent of the answers indicate that no special treatment whatever is given to steers the day before shipment. Of the remainder, the great majority use timothy hay and reduce the grain feed. Twelve per cent place the steers in a dry lot before shipment. It is generally agreed among careful feeders that cattle should be taken off corn the day before loading and given all the hay they will eat, preferably timothy, with a good feed of oats amounting approximately to 5 lbs. per head. They should be allowed water until the morning when they are driven to the pens. Special attention should be given to start early, in order that they may be driven slowly. This method will insure a minimum shrink between feed lot and shipping station, while an excessive amount of feed and water, together with rapid moving of fat cattle, is certain to cause scouring and excessive shrinkage. Proper treatment before shipping insures cattle arriving on the market in a dry condition which is of great importance to the shipper as they will not only take on a reasonable fill, but be much more attractive to the buyer. One very interesting feature of the answers to this question is that the cattle feeder is thoroughly convinced of the fact that an excessive fill on the market is detrimental rather than beneficial as buyers refuse to bid on such cattle until late in the day when they have lost most of it. It was found that 85 per cent of the men who ship their cattle, either accompany them to market or arrange to be on the market the day the cattle are sold. This shows that the man who ships cattle appreciates the value of being on the market at the time they sell in order that he may not only understand the factors that enter into the selling price

or market value of cattle, but that he may also see that the commission firm uses proper care in handling them.

BEDDING CARS BEFORE SHIPMENT.

The information secured on bedding cars is interesting as it shows that the general practice with fully 90 per cent of Indiana shippers is to bed their cars with straw. This is due of course to straw being more available than other coarse products which would be suitable for this purpose. Other bedding materials that are recommended are corn stalks, clover chaff, refuse from the feeding of shredded fodder, saw dust, sand and damaged and inferior hay. Ninety-nine per cent bed cars with some one of these materials before shipment.

WHERE CATTLE ARE MARKETED.

Twenty per cent of the cattle feeders dispose of their product locally; 29 per cent sell to traders or shippers and 51 per cent both feed and market their own cattle. Judging by the reports, the Union Stock Yards of Chicago receive 40 per cent of all fat cattle marketed from this state; the Indianapolis yards receive 30 per cent and those remaining are marketed in other cities such as Buffalo, Cincinnati, Pittsburg, Louisville and Cleveland, in the order named. In answer to question 70, as to what months cattle are sold, the months are given in order according to the number of cattle marketed as follows:—July, May, June, April, December, March, September, October, August, February, January and November. The replies as to when cattle are disposed of seem to indicate that winter feeding is more generally practiced as the larger number answered :—"During the spring and early summer".

MARKETING CATTLE.

The greater portion of answers to question 71 give the age at which cattle are marketed as from 2 to 3 years. Less than 10 per cent of the cattle being marketed in the state are yearlings. The average weight of fat cattle marketed is 724 lbs. for yearlings; 983 lbs. for two-year-olds and 1278 lbs. for three-year-olds. This would indicate that many feeders are handling a class of cattle which do not possess the quality and breeding which will justify making them prime, or that they are not making them fat enough to secure their highest market price and a greater profit. The shrinkage on cattle from feed lot to market is estimated at 25 lbs. per steer. This varies with the age of the cattle, weather conditions at time of shipping, and other factors, but the amount given is a very fair average. Ten per cent of the feeders reporting, market their cattle

as prime or in finished condition; 24 per cent, as choice or some similar grade; 26 per cent as good; 27 per cent as fair to medium and 13 per cent as butcher stuff.

THE FINANCIAL PHASE OF CATTLE FEEDING.

In answer to question 77 " What margin between cost of feeders and selling price of steers is necessary to break even? " the highest margin mentioned was $3.00 and the lowest was 20 cents per hundred. The average of all answers was $1.07 per hundred. As this includes the feeding of cattle of various ages and classes, to different degrees of fatness or finish and through different lengths of feeding periods, it would be fair to conclude that it is necessary for cattle to increase 20 cents per hundred per month while fattening for market. In other words, the cattle feeder thoroughly appreciates the fact that it it impossible to finish cattle at a cost per hundred equal to or less than their selling value, hence the profit in feeding depends largely upon the margin between the buying price of feeders and selling price of fat cattle.

COST OF PRODUCING BEEF.

The factors which control the cost of producing beef in the feed lot are : the season of the year; the kind of ration fed; cost of feeds; the age; the quality and type of steers; the previous treatment and the condition of the cattle; the degree of finish attained; the value of manure and pork produced. The reply to question 78 " What does it cost to produce a pound of gain in summer and in winter? " proves conclusively that gains are made more cheaply in summer. The average of all answers was 7.2 cents in winter and 4.8 cents per pound in summer. A difference of 2.8 cents between the cost of gains for the two seasons is entirely too great for cattle receiving a full feed of grain. The Missouri Station* has experimented on this question for a series of years, the results of which show the cost of gains to be 22 per cent greater in winter. It must be assumed that in answering this question, a large number of feeders include gains on steers which were grazed without grain which would necessarily reduce the average cost for the summer season. The cost of gains in winter is also somewhat lower than the results of the work of the Purdue Experiment Station in fattening for the market, would indicate. Although the variation in price of feeds may account for considerable difference in cost of producing beef, these figures seem to indicate that the cattle feeder does not fully appre-

* See Bulletin No. 76, Missouri Experiment Station, Columbia, Mo.

ciate the cost of production when full feeding or else the cattle are marketed before they are finished. The latter assumption is probably correct as indicated in the replies to question 71.

COST OF PRODUCING FEEDERS.

The cost of a calf at weaning time (5.1 months of age as shown in question 20) taking an average of all answers, is $12.82; at 12 months of age, $20.62 and at 2 years of age, $32.76. This would indicate that under the average conditions a cow could be kept for $1.08 per month while raising her calf to weaning time, which would presuppose that she was either fed on very cheap feeds or if fed grain, that she would have to be milked at least a part of the time to offset this additional expenditure. From weaning time until the calf is one year old, it would cost 98.7 cents per month and from 1 to 2 years old, $1.01 per month. Using these figures as a basis, the conclusion may be drawn that a more expensive ration is fed the calf from weaning time until one year old than from 1 to 2 years old. On the basis of these estimates it would seem that the production of feeders would be a profitable business, as feeders for several years have sold for more than these reports would indicate the cost of production to be. However, it is doubtful whether these estimates should be taken as a guide.

FEEDING BEEF CATTLE MAINTAINS SOIL FERTILITY.

The question of maintaining soil fertility is one that concerns every farmer in the state. As shown by analyses of feeds used in experimental feed lots * frequently a farm crop contains plant food in the form of nitrogen, phosphoric acid and potash, which if replaced in the form of commercial fertilizers, would actually cost more than the average selling value of the particular crop. This is especially true of rough feeds such as clover, shredded stover and wheat and oat straw.

If these same crops are fed to beef cattle, less than 10 per cent of this plant food is sold when the animal goes to market. The extensive cattle feeder usually buys a sufficient amount of plant food in the form of bran, cotton seed meal or linseed meal to replace this 10 per cent, hence, is in reality not decreasing but is continually increasing the total amount of plant food on the farm. Another feature in the upbuilding of soil is the supply of humus which should not be ignored as it is of vegetable origin and cannot be purchased on the market; the live stock feeder is continually adding to the sup-

* See Purdue Experiment Station Bulletin No 115, on "Steer Feeding", p. 316.

ply in the soil while the grain farmer must necessarily diminish it unless he devotes a considerable part of his land to clover, cow peas or some other intermediate crop.

In answer to question 82 it was found that the use of commercial fertilizers is not general among cattle feeders, while 96 per cent of the replies to question 85, indicate that their soils are not only maintaining their fertility but are actually increasing in production. This brings out in a very forcible manner the fact that cattle feeding is a certain and definite means of soil improvement. Further information was desired on this important phase of the subject so we asked for the average value of the land devoted to this purpose, which was reported as $97.55 per acre. The average value of all land in the state is not over $60.00. which means that beef is being produced on land that is worth over one-half more per acre than the average.

HOGS A NECESSARY ADJUNCT TO BEEF CATTLE.

In answer to the question "Do you find beef production profitable unless you consider hogs in connection?" 12 per cent report that it is, while 88 per cent report that it is not possible to feed cattle profitably unless hogs follow. This is in accordance with the results of the Experiment Station work, in which it has been determined that unless the best of rations are used, it is impossible to derive a profit except by the use of hogs in connection with cattle. The replies state that the number of hogs used per steer is 1.5. This evidently means that some feed in addition to that fed to steers is given to hogs, as we find in our work that the waste will not support more than one hog to a steer. The average age of hogs preferred by cattle feeders, for following steers, is 5.1 months; the average weight, 92 lbs. This would indicate that they prefer an active hog which has not been crowded as the weight given presupposes such hogs have been kept largely on a growing ration thus developing rather a large frame and a small amount of fat in proportion to the weight.

Out of 634 answers to question 93, "Which breed of hogs is preferred?" 400 indicated Poland China; 120 Duroc Jerseys; 53 Berkshires; 27 Chester Whites; 2 Hampshires and 6 O. I. C. The others expressed no preference. The average rate of gain per head on hogs following cattle in the feed lot is reported as 1.4 lbs. per day. This agrees with the answers to questions 91 and 92 as it is only a growthy sort of a hog which is able to make so great a daily gain in the cattle lots.

IMPORTANT PROBLEMS DEMANDING ATTENTION.

In answer to question 98, "What is the most important problem

before the cattle feeders at the present day?" 239 reported, securing feeders; 216, methods of feeding; 284, price of either feeders or of fat cattle; 67 foreign markets; and 52 packers. This would seem to indicate that the question of obtaining good feeders at a price that will justify feeding them out into marketable condition at prevailing prices of feeds and fat cattle, is the most serious one that confronts the cattle feeder. Proper methods of feeding steers is another thing that seems to be demanding a great deal of thought and attention. It would also indicate that the cattle feeders realize that under present conditions they will have to change their former methods of feeding in order to obtain any profit from the operation.

In answer to question 99, "What information in regard to methods of feeding would enable the feeder to handle cattle more profitably?" there were a great variety of answers. In the majority of cases information in regard to the proper methods of selecting and preparing the ration from farm grown feeds was considered as most important.

FEEDING VS. MARKET VALUE OF FARM CROPS.

In answer to question 100 as to the relative feeding and market value of different crops that are grown upon the farm, it will be interesting to give a complete statement of the average of all answers which is shown in the following table:

	Aver. Selling price.	Aver. Feeding value.	Percentage increase over selling price.
Corn per bushel	$.39	$.49	25
Oats per bushel	.28	.33	17
Clover hay (loose)	5.56	7.27	30
Timothy hay (loose)	7.47	7.65	2
Oat straw	3.00	3.61	20
Shredded fodder	4.28	4.74	30
Wheat straw	2.34	2.63	12
Corn fodder, per shock	.17	.19	11
Stalk field, per acre	.72	1.03	43

This matter is of great interest to cattle feeders and would indicate that not only is it possible to grow greater crops on lands devoted to this business, but that these same crops will bring from 2 per cent in the case of timothy hay, to 43 per cent more in the case of stalk fields, when fed to beef cattle than when sold on the market. It is also interesting to note that general practice agrees very largely with the summary of these reports, in that the crops usually grown and fed to beef cattle, such as corn, corn stalks in various forms, and clover hay, show a much greater difference between selling price and feeding value than do timothy hay and wheat straw.

INDEX

PAGE

Introduction ____ 1
List of questions ____ 2
Distribution of replies ____ 7
The extent of the business ____ 8
Beef production adapted to large farms ____ 8
Beef farms are largely devoted to corn and grass ____ 9
Legumes appreciated by cattle feeders ____ 9
Shelter for fattening steers ____ 10
Favorable conditions in feed lots advantageous ____ 10
Adequate supply of pure water necessary ____ 11
Raising and buying feeders ____ 11
Better cattle can be produced than bought ____ 11
Cattle feeders do not raise their own cattle ____ 12
The advantage of purchasing feeders over raising them ____ 13
Feeders prefer two-year-old steers ____ 13
Baby beef ____ 14
Preparation of feeds ____ 14
Oats as a cattle feed ____ 15
The use of supplemental feeds ____ 15
Clover hay roughage most extensively used ____ 16
Methods of utilizing corn stalks ____ 16
Silage as a factor in beef production ____ 16
The use of concentrates with silage ____ 20
Pasture produces cheap and economical gains ____ 20
Wintering stockers and feeders ____ 20
Winter vs. summer feeding ____ 21
Winter feeding profitable in Indiana ____ 21
Turning full fed steers on grass ____ 21
Methods of feeding ____ 22
Use of self-feeder ____ 22
Roughage usually fed in unlimited quantities ____ 23
Grain consumed by steers on full feed ____ 23
Gains more expensive in winter than in summer ____ 23
Cost of gain increases with age of cattle ____ 24
Gains secured under different methods of feeding ____ 24
Method of wintering influences gains in following summer ____ 25
Small gains on stockers in winter ____ 25
Gains made on grass without grain ____ 26
Preparation of cattle for shipment ____ 26
Bedding cars before shipment ____ 27
Where cattle are marketed ____ 27
Marketing cattle ____ 27
The financial phase of cattle feeding ____ 28
Cost of producing beef ____ 28
Cost of producing feeders ____ 29
Feeding beef cattle maintains soil fertility ____ 29
Hogs a necessary adjunct to beef cattle ____ 30
Important problems demanding attention ____ 30
Feeding vs. market value of corn crops ____ 31

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 13.

LaFayette, Ind., June, 1908.

MILK PRODUCTION

II.

FEEDING.

By Herbert A. Hopper.

The loss occasioned each year through the improper feeding of dairy cows is enormous. If the dairy herd is properly housed, fed and handled, milk production is a profitable business in spite of the present high prices of feeding stuffs. Proper housing, fortunately does not necessitate expensive buildings. Any enclosure offering sufficient light, ventilation and warmth, if provided with comfortable fastenings or stalls to protect each cow from injury by her neighbors, will suffice. If then the cows are kept clean, dry and well bedded, the requirements of good housing are met. Good management of a herd presupposes the elimination of all low producers, for in spite of proper care and feeding, some cows are unable to yield profits. The dairyman should first concern himself with the removal of those cows that, given a reasonable opportunity, have proved profitless. He then faces the question of rational feeding, a matter of great importance to many, especially the milk producers of Indiana.

Object.

The Experiment Station has received so many requests for help in formulating rations for dairy cows, that it has been thought wise to answer them in the following way, with the essential prin-

ciples and facts thus far known to be useful in feeding for milk production. The teachings of the best American authorities, together with our own experience and that of other practical dairymen has been drawn upon with the hope of inducing others to feed more intelligently. Dairymen need, not so much new facts, as the courage to put into practice what has long been known. It is not to be supposed, however, that the future may not modify in some degree our present knowledge.

Study Essential.

The feeding of a well-bred dairy cow so as to obtain continuous, maximum, economic returns, is possible only through knowledge and experience. An early recognition, that the dairy cow is a mother, and should be treated accordingly, will do much to pave the way for better methods. Seldom, however, do two cows have similar tastes or equal capacities, either in the amount of food eaten or in the use made of it. For obvious reasons, foods vary widely in their nutritive value. The nutritive requirements of cows vary as their lactation progresses. These needs cannot be satisfactorily supplied through guess work; study is essential.

Digestibility.

The dairy cow requires bulk in her ration, for the reason that she is a ruminant, but coarse, woody, non-nutritious substance cannot be profitably consumed. For example, the dry matter in swale hay is only 39% digestible, in red top hay 46% digestible, and in timothy hay (after bloom) 53.4%. On the other hand, the more digestible hays in this respect are as follows: Hairy vetch 69.4%, white clover 67.2%, and dried pasture grass 72.6%. The dry matter of corn cobs is only 51.4% digestible, of cotton seed hulls 39.8%. Since only the digestible portion of a food can contribute to productive purposes, this quality should always receive consideration. The straws in general carry large quantities of inert matter. The dry matter in rye meal is 87.3% digestible, in cotton seed meal 73.7%, in oil meal N. P. 79.2%, and in corn meal 89.4%. Corn is one of the most digestible grains, and cow's milk is practically all digestible. A ton of good timothy hay contains 952 pounds of digestible nutrients, a ton of cow pea hay 1010 pounds, and a ton of alfalfa 1036 pounds. Timothy hay is undesirable food for a dairy herd. In selecting foods, digestibility and bulk must always be considered.

Feeding Whole Grain.

Experiments upon this subject are not numerous, but the results obtained are emphatic. In three trials with horses, grinding increased digestibility of corn and oats from 3.3% to 14%. In one trial with wheat there was a gain of 10% in digestibility. In one

with corn, grinding increased digestibility 7%. Bulletin 242 of the Michigan Station offers some exact data upon the subject of feeding whole grain to cows, heifers and calves. When whole corn was fed to cows 22% was unmasticated, when fed to heifers 10%, when fed to calves 6%. Chemical analysis showed no change in composition of the unmasticated parts, so it is a safe assumption that the animal derives no benefit from grain that passes through the digestive tract unaltered. The germinating power of the grain passing through was greatly affected though not entirely destroyed. The conclusion is that, whole grain fed to dairy cows and heifers is a wasteful practice. Seldom will the expense of grinding equal the waste. Grinding facilitates rapid and thorough digestion, and consequently should be in great favor with dairymen.

Combination of Foods Desirable.

Many foods fed singly are not as completely digested as when used in combination with others. In other words, certain materials, if consumed in a ration with others, are capable of being more completely digested themselves and may exert a beneficial effect upon the digestibility of the remainder of the ration. The value of milk added to the rations of different animals, as well as increased digestibility from certain combinations of grain, has been noted, but details have not been worked out. The lesson should be to use a variety.

Amount of Food Consumed.

Under normal conditions, moderation is Nature's rule. The modern dairy cow, however, is a product of special selection, whose value largely depends upon her capacity to consume comparatively large quantities of food. The point which concerns the feeder is not the amount consumed, but rather the use made of it. While experiments to determine the influence of quantity upon digestibility have not been entirely decisive, they seem to indicate that with dairy cows, when the amount of food (quality, etc., being unimpaired) is fairly within the normal capacity of the animal, it is as well digested as smaller amounts. We must not fail to understand that the animal is improved largely because of this greater capacity for food. Liberal feeding to animals of large capacity should be the milk producer's aim.

Palatableness.

We all know from experience that foods which are relished are likely to be consumed in abundance. This character conduces to liberal consumption and indirectly to large production. Palatableness is, therefore, an important factor in feeding, as it stimulates digestion. It conduces to thoroughness of digestion and economy of

returns. It is usually not present in over-ripe or fibrous plant tissues, because of the disappearance at that stage of development in considerable degree of the essential oil to which it is attributed. Palatableness usually accompanies a good mechanical condition in forage or concentrate. Stage of ripeness of a forage crop determines very largely its palatableness and nutritive value.

Individuality.

While there are slight individual differences in digestive efficiency among cows, extensive experiments have shown that these are insufficient to account for the widely variable returns made by similar cows from like quantities of the same kind of food. The results obtained in tests of this kind are emphatic. It has been shown that, of two cows of apparently the same merit, from superficial examination, one may return three times as much as the other from a given amount of similar foods. They digested their food equally well. It is a well known fact that there are individual likes and dislikes among cows, which necessitate an intimate knowledge of each cow if best results are to follow. Occasionally a cow will make her best performance upon a ration not suited to the other members of the herd. These matters are of continual interest to the dairyman who should safeguard himself at all times by keeping at least approximate records of food consumed and product yielded by each individual.

Miscellaneous Considerations.

Various means of preparing foods have been resorted to in the past. Those that are cooked are no more digestible than the same uncooked. In fact, some parts are rendered less digestible through heating. Animals may consume more of it, which many times will account for the apparent good results. Wetting, except in special instances, when it is desired to tempt an ailing animal, is of doubtful value. If fermentation takes place, it may slightly increase digestibility, but should not be made a regular practice with the foods ordinarily used.

Drying, in general, does not exert any unfavorable influence upon digestibility if not excessive. However, most green foods are slightly more digestible than the same material as it is usually cured.

Certain foods known to have laxative qualities should find a place in nearly every ration. Those in which it is pronounced should be fed moderately, as an over-stimulation of the digestive tract in this manner may prevent complete absorption of the nutrients, through an early expulsion of the same from the body. Again, as concerns the product, certain foods produce hard while others produce soft fats in the butter. Of the former may be mentioned cotton

seed meal and buckwheat middlings, while to the latter belong linseed oil meal and the gluten meals.

No single food or combination of foods has yet been used, that will permanently increase the percentage of butter fat in the milk of an individual cow. In the light of present knowledge, *it is impossible to feed fat into the milk of a cow in normal condition.* The quantity of milk can be influenced by feeding.

Salt is essential to health, but does not appreciably increase digestibility. Some cows are so greedy for salt that, when allowed to help themselves, they will eat so much as to produce scouring. Such are exceptional cases.

Sanitary Conditions.

Aside from the quality of the product, sanitation pays and pays well. Sunlight is Nature's greatest germ killer and promoter of growth. Experiments with calves have shown that under the same conditions of feed and care, those furnished sunlight made better gains in weight and were more vigorous than those confined in dark quarters. Dairy cows always appreciate a congenial environment. Much available energy is wasted by compelling a cow to warm up a cold damp room or dry out saturated bedding. If these comforts are not furnished the cow, she uses considerable food in an attempt to secure them.

Balanced Rations.

Ration, is the term applied to the amount of food consumed by an animal in 24 hours. There are various kinds of rations to meet the needs of a variety of animals under different conditions. When the food requirements of an animal are approximately met, no more, no less, its ration is said to be balanced. A ration suitable for a draft horse at work will not be balanced for one at rest. Neither will the ration that sustains a cow producing 15 pounds of 3.2% milk be adequate for one of the same live weight producing 35 pounds of 4% milk. The expression, "balanced ration," is a relative term and depends upon the food requirements of the animal and the amount of digestible nutrients in the foods available.

The nutrients contained in all feeding stuffs, animal bodies and milk, may be divided for convenience into the following classes:

Water
Ash (mineral matter)
Protein (nitrogenous matter 16% nitrogen)
Carbohydrates (sugar, starch, cellulose)
Fats or oils.

The first two need no consideration here, because water, though essential, is secured at practically no expense and any ration with a semblance of variety will contain enough mineral matter for the

needs of all farm animals. The use and importance of the three following should be carefully studied by the dairyman.

Protein.

This is another name for the group of nutrients in foods which are rich in nitrogen. Many times they are spoken of as nitrogenous foods, because they are composed on the average of 16% of the element nitrogen, the element which is essential in the growth of either plant or animal. As examples of foods rich in protein, we may mention such concentrates as oil meal, cotton seed meal and gluten meal, and the leguminous hays from alfalfa, cow peas, soy beans and clover. From the leguminous plants (those that secure most of their nitrogen from the air) the forage and seeds are rich in protein. Lean meat, white of egg and the casein of milk are customary examples of protein.

The principal uses of protein by the cow are to build muscle, replace broken down tissue, and form the casein of milk. The cow's food does not contain casein; she makes it from the protein in her food. Successful feeding of the dairy cow depends much upon the proper use of protein. The selection of foods should be carefully made, first because those used are often deficient in protein; second, because no other nutrient answers the same purpose.

Carbohydrates.

Carbohydrates include such substances as sugar, starch, and crude fiber as they exist in the different foods. This group constitutes the larger part of the food consumed by farm animals, and when burned in the body, it furnishes the heat and energy for body functions and muscular activity. They are actually burned within the animal, the heat not needed to maintain temperature being thrown off. Milk solids draw heavily upon the energy of the cow. When carbohydrates are fed in excess of the demands of the animal body, fat may be formed. They are the source likewise of milk sugar and butter fat.

Fat.

Fats or oils are common in both plant tissues and seeds, and in the animal body, where they are characteristic of the species. The rough fodders contain comparatively small amounts while cotton seed, flax seed, and corn contain large amounts. Fats perform the same function in the animal body as do carbohydrates, with the exception that they are 2¼ times as valuable. Fats and carbohydrates are interchangeable, one may take the place of the other, but neither can assume the function of protein. No more muscle can

be replaced or built up, or casein produced, than there is protein in the food. Protein can take the place of carbohydrates or fats when either is deficient, though this is an expensive substitution, but no amount of carbohydrates or fats will make up for a deficiency of protein.

Food of Maintenance.

The vital activities of the body require a certain amount of food for their support. This is called the maintenance requirement or the maintenance ration. A cow weighing 1,000 pounds in normal condition on the average will require .7 pound protein, 7 pounds carbohydrates and .1 pound of fat in a digestible form, to maintain her without gain or loss in weight. Such a ration supplies nothing for growth, work or other purposes. Its importance lies in the fact that returns in the form of a product cannot be expected until something more than a maintenance ration is being consumed by the cow. So long as the cow makes proper use of her food, the more she will eat above maintenance needs, the more profitable she will be. Cows that are hearty feeders usually yield profits.

Digestible Nutrients.

Not only is there a difference in the digestibility of the total dry matter in different feeds, but there is likewise a difference as to digestibility of the proteids, carbohydrates and fats from different sources. There is a difference between total nutrients and total digestible nutrients. As the digestible nutrients are the only ones considered in making up rations, these only are given in the table of composition at the close of this circular.

Proper Feeding.

In order to meet the food requirements of any cow, the composition of her milk and food should first be known. This knowledge can only be obtained through chemical and Babcock tests of the milk, and through feeding experiments to determine the amount and relative value of the various nutrients the animal is able to obtain from the foods in question through digestion. Countless samples of milk from cows of different breeds and different grades have been tested while their food requirements were being studied. The digestible nutrients that all the common foods contain on the average are now known, as well as the amount of digestible protein, carbohydrates and fats that the ordinary dairy cow requires in order to produce 1 pound or 100 pounds of milk of known composition. The approximate composition of milks testing 3, 4, 5 and 6 per cent butter fat is given in the following table:

TABLE 1.

Composition of Milk.

Fat per cent.	Protein per cent.	Carbohydrates per cent.
3	2.8	4.5
4	3.2	4.9
5	3.6	5.0
6	4.0	4.9

From the above it will be seen that, as the butter fat increases, the protein content of the milk increases. Also, that the carbohydrates increase up to 5% butter fat, when they apparently cease to follow. It shows that a cow testing 5% butter fat requires more protein in her food than a similar cow producing only 3% milk. It has been shown, as would reasonably be expected, that the food requirements increase in quantity proportionately to the increase in quantity of any particular grade of milk, so that we should supply the protein and other nutrients according to the quantity as well as the quality of milk produced by the cow in question.

Of course, more food is needed than the mere composition of the milk would indicate. All foods and especially dry forage, will vary somewhat from the composition indicated in the table of digestible nutrients. There is a waste in converting the protein of the food into the protein of the body or the casein of milk. Mastication, digestion and elaboration cause an expenditure of energy, so that to the productive part of the ration must be added the maintenance or energy producing part before all the nutrients needed are determined. The following table gives the nutrients required for the production of one pound of milk of the quality indicated.

TABLE 2.

***Feeding Standards.**

For Milk Testing	Protein lbs.	Carbohydrates lbs.	Fat lbs.
3.0 % fat	.042	.19	.013
3.5 % fat	.045	.21	.015
4.0 % fat	.048	.23	.016
4.5 % fat	.051	.25	.018
5.0 % fat	.054	.27	.019
5.5 % fat	.057	.29	.02
6.0 % fat	.060	.31	.022
Daily maintenance per 100 lbs. live wt.	.07	.70	.01

*Prof. T. L. Haecker.

Nutrients for Maintenance and Production.

From the table just given it is easy to calculate the nutrients required by any cow providing her weight and the quality of her milk are each known. With a cow weighing 1,100 pounds and yielding 35 pounds of 3.5% milk daily, the calculation would be as follows:

	P.	C.	F.	Pro. lbs.	Carb. lbs.	Fat lbs.
For Maintenance: 11 x	(.07	—.70	—.01) equals	.77	7.7	.11
For 35 lbs. milk: 35 x	(.045—	.21—	.015) equals	1.57	7.35	.52
Daily requirement,				2.34	15.05	.63

In this way it is learned that the cow will require in her ration 2.34 pounds digestible protein, 15.05 pounds of digestible carbohydrates, and .63 pound digestible fat. Table 3, computed from Table 2, gives in convenient form for ready reference, the maximum standard requirements for a 1,000 pound cow.

TABLE 3.

Maximum Digestible Nutrients per Day for a 1000 Pound Cow for Maintenance, and the Yield and Quality of Milk Indicated.

		Protein lbs.	Carbohydrates lbs.	Fat lbs.	Nutritive Ratio
For Maintenance		.7	7.	.1	
20 lbs. milk	(3% B. fat	1.54	10.80	.36	1:7.5
	(4% B. fat	1.66	11.60	.42	
	(5% B. fat	1.84	12.80	.50	1:7.3
30 lbs. milk	(3% B. fat	1.96	12.70	.49	1:7.1
	(4% B. fat	2.14	13.90	.58	
	(5% B. fat	2.41	15.70	.70	1:7.0
40 lbs. milk	(3% B. fat	2.38	14.60	.62	1:6.8
	(4% B. fat	2.62	16.20	.74	
	(5% B. fat	2.98	18.16	.90	1:6.7
50 lbs. milk	(3% B. fat	2.80	16.50	.75	1:6.7
	(4% B. fat	2.90	18.50	.90	
	(5% B. fat	3.55	21.50	1.10	1:6.5
60 lbs. milk	3% B. fat	3.22	18.40	.88	1:6.3
70 lbs. milk	3% B. fat	3.64	20.30	1.01	1:6.1

In general, the amounts here indicated should be reasonably well adhered to, though exact conformity is not essential to good results. They are offered as practical guides, and should be used as such, though amounts in excess of those indicated will hardly prove profitable except in rare cases where the individuality of the animal dictates differently.

Selecting the Foods.

Assuming that all the requirements of the cow have been determined, the problem then becomes one of using the farm grown and other foods to best advantage, while satisfying the appetite and providing the nutrients needed in the right proportion. For the beginner, it is a matter of cutting and trying. However, there are some rules to be followed. An average cow will consume from 20 to 25 pounds of dry hay or roughness per day. When silage is used more total roughness will be eaten. For ordinary feeding, the grain will vary from 1-3 to 1-2 the weight of roughness in the ration. When cows are forced it may reach 2-3 the roughness. These amounts are to be varied of course with the weight of the animal and the product. A variety in the grain portion of the ration is usually more satisfactory than to employ a single ingredient, though circumstances will need to dictate in some cases as to which will be more profitable. With 30 pounds of corn silage usually 10 to 12 pounds of clover hay will be eaten. With this 4 pounds of corn meal and 3 to 4 pounds of wheat bran or ground oats, or their equivalent, should be given. Oil meal should be fed only in small quantities, 1 to 2 pounds, because of its loosening effect upon the bowels. Cottonseed meal having a slightly opposite influence can be fed in quantities somewhat greater than can oil meal. It is wise to make as large a use of corn as possible, both as roughage and grain, 4 to 5 pounds of corn meal being about the maximum to be safely fed continuously.

The physical nature of the ration requires attention as well as its nutritive properties. All ruminants require bulk in their food, though this point needs little attention where hays are fed freely. Heavy grains like corn meal, pea meal, cotton seed meal and various grades of middlings should be fed in combination with ground oats, wheat bran, etc., in order to improve the physical condition of the mixture and thus facilitate digestion. The selection of foods should be made with these thoughts in mind.

Practical Feeding.

Economical results in milk production must be sought through a greater production and use of farm-grown foods. The amount of grain which dairymen are now feeding varies from 7 pounds to 25 pounds per day, depending upon the individuality of the cow. In all but exceptional cases, medium quantities of both roughage and grain usually give better results than heavy feeding of either. In so far as nutritious hays like clover and alfalfa can be comfortably con-

sumed, their nutrients are as available for producing milk as are the nutrients of the concentrates. The only reason for feeding grain, is that the cow can use more nutrients than her capacity will permit her to obtain through the consumption of bulky material. Heavy feeding of grain, except where cows are being fed for large records, regardless of consequences, should give way to a liberal use of leguminous hays and silage, and such amounts of grain as are needed to furnish nutrients not already furnished by the roughness. Ordinarily, the amount of grain will vary from 6 to 12 pounds where nutritious roughness is supplied abundantly. It is not usually desirable to restrict to one kind of grain or mill feed as previously explained. When attempting to produce a ration entirely upon the farm, economy may dictate somewhat less variety than otherwise. Too much emphasis cannot be laid upon the importance and use of farm grown foods, for the common grains combined with corn silage, alfalfa, clover, or cow pea hay will give the same yield of milk and butter fat when rationally fed, as will the mill feeds, and on the whole they have a tendency to produce better results.

The herd should not be fed in a careless, wholesale fashion, but the requirements of each animal should be studied from the quantity and quality of her milk, making such allowances as are necessary for her particular weight. The standards previously referred to enable the feeder to determine each cow's requirements. For the practical dairyman it will be sufficient to divide the herd into groups considering their stage of lactation, amount of production and age, and compound a ration from the foods available, that will suffice for each group. Scales are as essential in feeding a well managed herd, as in determining their records of production. The amount in any case will soon be learned, and the labor will be found to be no greater than in the ordinary careless manner of feeding, but the results will be vastly superior. As the cows advance in lactation or the foods are changed, it will be necessary to calculate the rations anew.

Compounding Rations.

To illustrate the method, let us assume that it is desired to secure from corn fodder, clover hay, corn meal and wheat bran a ration for a 1,000 pound cow producing 30 pounds of 4% milk. Referring to the table of composition of digestible nutrients at the end of the circular, we note that cured corn fodder contains 2.5% of digestible protein, 34.6% digestible carbohydrates, and 1.2% digestible fat, and through multiplication by each of these amounts, we learn that 12 pounds of corn fodder contain .30 pound digestible protein, 4.15 pounds digestible carbohydrates, and .14 pound digestible fat. In the same way 10 pounds of clover hay contain .68 pound protein, 3.58 pounds carbohydrates, and .17 pound fat; 5 pounds of corn meal contain .37 pound protein, 3.33 pounds carbohydrates, and .21 pound fat; 6 pounds of wheat bran contain .73 pound protein,

2.35 pounds carbohydrates, and .16 pound fat. If these amounts were decided upon, the ration would offer nutrients as shown in No. 1.

RATION 1.

A Ration Commonly Used.

	Protein lbs.	Carbohydrates lbs.	Fat lbs.
Corn fodder 12 lbs.	.30	4.15	.14
Clover hay 10 lbs.	.68	3.58	.17
Corn meal 5 lbs.	.37	3.33	.21
Wheat bran 6 lbs.	.73	2.35	.16
	2.08	13.41	.68
30 lbs. 4% milk	2.14	13.90	.58



CUT 1. RATION 1.

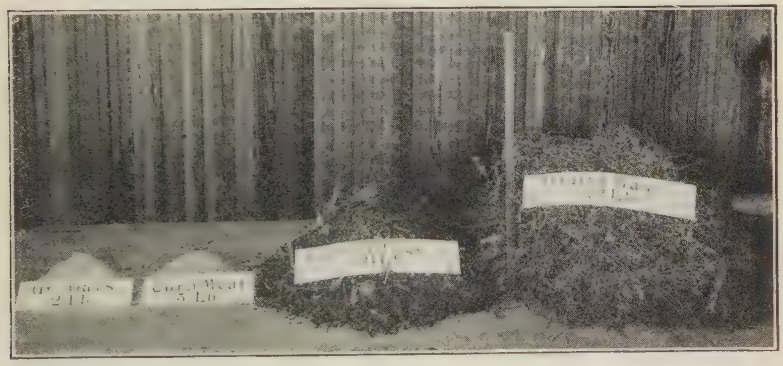
A NON-SUCCULENT RATION COMMONLY USED. THE INTRODUCTION OF CORN SILAGE WOULD GREATLY IMPROVE IT.

This ration contains 2.08 pounds of digestible protein, 13.41 pounds digestible carbohydrates, and .68 pound digestible fat. According to the standard for 30 pounds of 4% milk, it is slightly deficient in proteids, and lacks about .5 pound containing enough carbohydrates, while the fats are slightly in excess. For practical purposes, this is close enough to the standard, as variations in digestibility, wastes in feeding, and the efficiency of the cow must be considered. This illustrates a fair non-succulent ration from foods commonly available. The grain is half the weight of the roughness and has a good physical texture. By subtracting or adding to the amounts shown here a ration may be obtained for less or greater production. Exceptional circumstances might warrant the continued use of such a ration, but it is far less satisfactory than No. 2.

RATION 2.

An Economical Home-Grown Ration.

	Protein lbs.	Carbohydrates lbs.	Fat lbs.
Alfalfa hay 12 lbs.	1.32	4.75	.14
Corn silage 30 lbs.	.27	3.39	.21
Corn meal 5 lbs.	.39	3.33	.21
Ground oats 2 lbs.	.18	.94	.08
	2.16	12.41	.64
30 lbs. 4% milk	2.14	13.90	.58



CUT 2. RATION 2.

A SUCCULENT HOME-GROWN RATION. INDIANA DAIRYMEN SHOULD SEEK TO REDUCE COST OF PRODUCTION BY FOLLOWING UP THIS SUGGESTION.

This is a palatable, nutritious ration differing materially from the former. It contains enough protein and fat, but is deficient in carbohydrates. Usually, it is difficult to obtain enough proteids, but here is a farm-grown ration deficient in carbohydrates. The use of alfalfa hay obviates the necessity for much nitrogenous concentrate. If alfalfa hay is not available, equal quantities of cow pea hay may be used in its place. The deficiency in carbohydrates can be easily corrected by feeding a small amount of corn stover each day in addition to the ration as it stands. It will hardly pay to purchase oats at present prices, but when they are grown upon the farm it may be a different question. They are a valuable food for the dairy cow and as small a quantity as 2 pounds will be useful mixed with corn meal. Other grains could be used. This ration illustrates a fact of great significance to the milk producer and should encourage him to utilize more carefully the opportunities offered by each farm for producing all the food for the herd, as it is here shown that a satisfactory ration can be thus secured.

RATION 3.

Concentrates Expensive, Roughness Not Palatable.

	Protein lbs.	Carbohydrates lbs.	Fat lbs.
Corn stover 14 lbs.	.23	4.53	.09
Timothy hay 8 lbs.	.22	3.47	.11
Corn meal 4 lbs.	.31	2.66	.17
Wheat bran 3 lbs.	.36	1.17	.08
Cotton seed meal 2 lbs.	.74	.33	.24
Oil meal, N. P. 1 lb.	.28	.40	.02
	2.14	12.56	.71
30 lbs. 4% milk	2.14	13.90	.58



CUT 3. RATION 3.

A POOR RATION FOR THE DAIRY COW. THE ROUGHAGE IS NON-NITROGENOUS AND NOT PALATABLE. THREE-FIFTHS OF THE CONCENTRATE MUST BE PURCHASED, WHICH IS POOR ECONOMY. COMPARE WITH CUT 2.

The reader will observe that each ration thus far given, contains practically the same quantities of digestible nutrients. They illustrate how foods of different character and composition may be combined to meet the same object. In the light of previous remarks, there is, however, a difference between the rations as concerns cost and influence upon continued production. As will be seen in No. 3, the nutrients, while available, are either expensive or in a non-palatable form. When well cured and reasonably fresh, corn stover is a good food, but timothy hay should find a place in the dairy cow's ration only as a last resort for roughness. The cuts shown illustrate the three rations discussed.

To recapitulate, rough foods should be given freely, up to the animal's individual capacity for them, and grain of a well balanced nature added in proportion to the amount of milk, when the latter is of average composition. A large use of roughness is desirable, yet it will always be profitable to supplement with concentrates. Often when on pasture some hay and a light feed of grain is desirable if continuous maximum results are sought. In feeding each cow, continue to increase the grain gradually as long as she responds with an increased flow. When she fails to increase, reduce the grain gradually until she shows signs of decreasing. The ration that just holds her production at this point is most profitable. Of course, as the lactation period progresses, there will be a natural decline in the production of milk, which will necessitate a corresponding change in the ration.

Nutritive Ratio.

Referring to the function of the various nutrients it will be seen that carbohydrates and fats are used for similar purposes in the animal body. With any food or ration, the nutritive ratio shows the proportion of proteids to the carbohydrates and fats taken together. The value of the fat, however, is 2¼ times that of the carbohydrates for producing heat or energy. Consequently, the fats are reduced to a carbohydrate equivalent by multiplying by 2¼, then added to the carbohydrates and the sum divided by the proteids which gives the nutritive ratio. The nutritive ratio of ration No. 3 is obtained as follows:

.71 lb. fat x 2¼ equals 1.59.

12.56 lbs. carbohydrates plus 1.59 equals 14.15.

14.15 ÷ 2.14 = 6.6

For each pound of proteid material, this ration offers 6.6 pounds of carbohydrates and fats, so it is said to have a nutritive ratio of 1:6.6. Rations of this kind are called narrow, but where the carbohydrates and fats are in greater abundance, as for example 1:12 or 1:20, they are designated as wide rations. Rations having a nutritive ratio of from 1:6.0 to 1:7.5 are best suited for dairy cows.

Phenomenal Producers.

Experience has clearly shown that no set rule, if adopted as a standard for the care and feeding of the dairy cow, can be depended upon to yield maximum results in any given case. The individual likes and dislikes of each animal must be studied by the feeder. Good herdsmen are born with a love for the cow and a natural intuition for understanding her wants, a power not acquired from others or learned from books. Large producers are uniformly hearty eaters. Definite rules do not always hold in these cases, though doubtless the principles of feeding do, but at best such animals are largely a law unto themselves.

Succulence and Silos.

It is essential for large yields and economical results that some succulent foods be given the herd during the winter months. This can be supplied either through the use of root crops or by using silage from different sources. Roots are a useful form of succulence, but the cost of labor necessary to grow them precludes their general use in this country. In view of the fact that corn yields digestible dry matter more abundantly, with a reasonable expenditure of labor than any other plant, its use in the form of silage is universal. Corn silage is especially suited to all intensive operations where it is necessary to support as many animals as possible on a small amount of land. Like the plant from which it is made, corn silage is carbonaceous, yet its succulence stimulates milk secretion to a marked degree and its generous use in winter is the best way to approach ideal summer conditions. Clover, alfalfa and cow peas may be fed in the form of silage, but their use in this manner is not common. If the planting of cow peas is so timed that they will reach maturity when the corn crop is ready for the silo, one load of green peas to two loads of corn will make excellent silage and overcome the risk and labor of curing the cow pea hay. The silo is a necessary part of the equipment of any well regulated dairy farm, and its value is highly appreciated by feeders of all forms of live stock. No dairyman who has ever made and fed silage properly would forgo the advantages offered by it, They contend that it is essential to success. Too much cannot be said by way of inducing Indiana farmers to use silos more extensively. Instead of wasting one-third the nutrients of the corn crop each year by allowing the stover to waste in the fields, the whole crop should be converted into silage and fed to dairy cows in well protected stables and yards. The returns from the increased production of milk would add millions of dollars annually to the farmers' revenue. No farmer keeping ten or more cows can afford to hesitate about purchasing a silo. The books mentioned at the close of this circular should be consulted for further information.

Soiling Crops and Summer Drought.

Too much dependence is usually placed upon pasture for summer feeding. At best it is uncertain and the wise man will insure a high yield during these months when drought is practically inevitable, by providing a succession of green growing crops that can be fed when pastures fail. Pasturing high priced land is unprofitable in these times. Few stop to consider the destructive effects of trampling, that, while a cow is taking one bite of grass, she is perhaps soiling or trampling the life out of four others. A succession of fresh soiling crops can be provided and used to great advantage in tiding the herd over the period of drought, heat and flies. The following list has been found applicable to Indiana conditions and any farmer can work out from it a succession suitable for his needs. If sufficient silage is put up each year part can well be used for summer feeding,

TABLE 4.

A Succession of Crops for Soiling Purposes.

Crops.	Time of sowing.	Seed per acre.	Approximate time of use.	Approximate yield of green feed per acre.
Rye	Sept. 20	6 to 8 pecks	May 10 to May 20	3 to 5 tons.
Wheat	Sept. 25	6 to 8 pecks	May 20 to May 30	3 to 4 tons.
Alfalfa	April to August, previous yr.	20 pounds	June 1 to June 10	6 to 8 tons.
Peas and Oats	April 1st	1½ bu. of each	June 10 to June 20	5 to 7 tons.
or				
Red Clover	March, previous year	10 to 15 pounds.	June 10 to June 20	3 to 5 tons.
Peas and Oats	April 10 to 15	1½ bu. of each	June 20 to June 30	4 to 5 tons.
Alfalfa	Second cutting.		July 1 to July 10	6 to 8 tons.
Early Corn	May 1 to May 10	1 bu. to 5 acres	July 10 to July 20	8 to 10 tons.
Early Corn	May 10 to May 15	1 bu. to 5 acres	July 20 to August 5	8 to 10 tons.
Alfalfa	Third cutting		August 5 to August 10	4 to 6 tons.
Corn	May 1 to May 20	1 bu. to 6 acres	August 10 to Sept. 1	10 to 12 tons.
or				
Cow Peas	May 20	3 pecks	August 10 to Sept. 1	6 to 8 tons.
Sorghum	May 20	½ bu	August 20 to Sept. 10	8 to 10 tons.
Late Corn	June 1	1 bu. to 6 acres	Sept. 1 to Sept. 20	10 to 12 tons.

A plan for a succession of crops that will be found practicable throughout the State. The dates for sowing and cutting will vary somewhat for northern and southern sections. From Bulletin No. 120, Purdue Experiment Station.

which will be found less laborious than the daily hauling of green crops for the herd. Some green crops should be available every year in addition to pasture, and if not needed for summer use, they will make excellent hay for winter feeding. The herd must not be allowed to shrink in flow unduly, as it is practically impossible to bring them back during the same lactation. The young stock, destined for future producers, must not be neglected on short pasture, for the labor and expense of supplying their needs as above indicated for the herd, is insignificant compared with the importance of their unimpaired growth. It will always be well to provide a variety of soiling crops and to feed Canada peas, clover, alfalfa or cow peas with corn to balance the ration. The introduction of new crops, or the adoption of any system that will provide a continuous supply of such foods, will necessarily be the ambition of every progressive dairyman.

Caution.

The Purdue Experiment Station is being constantly reminded that large quantities of so-called stock foods are being fed annually by Indiana dairymen. The extravagant claims made for the nutritive and tonic properties of these mixtures are seldom actually realized when put to the test. The principle upon which they are prepared and used is entirely wrong. If an animal is out of condition, it needs specific treatment; if in good health it requires nothing but plain, wholesome food. Their use is a confession of bad management, for no herd intelligently fed during the winter needs to be "doped" into condition in the spring. Aside from the principles involved, there is a financial consideration in that the purchaser pays an excessive price for ingredients that are no more effective than many foods always available upon every well regulated farm. When it seems necessary to use commercial feeding stuffs, the purchaser should buy usually with an eye to the cost per pound of digestible nutrients, especially protein. Protection in this regard is furnished by the Indiana Feeding Stuff Control law, set forth in Circulars 6 and 7 of this Station, which can be had upon request.

Those who desire to pursue the subject of feeding farther will do well to secure at least one of the following books, and a familiarity with them all will be of great help:

Feeds and Feeding: W. A. Henry, Madison, Wis.

The Feeding of Animals: W. H. Jordan, Rural Science Series, MacMillan Co., New York, N. Y.

Forage Crops: E. B. Voorhees, Rural Science Series, MacMillan Co., New York, N. Y.

Chemistry of Plant and Animal Life: Harry Snyder, MacMillan Co., New York, N. Y.

Profitable Stock Feeding: H. R. Smith, Lincoln, Neb.

Feeding Farm Animals, Thomas Shaw, Orange Judd Co., Chicago.

TABLE 5.

Average Amount of Digestible Nutrients in American Feeding Stuffs. From Henry's "Feeds and Feeding."

	Digestible Nutrients in 100 lbs.		
	Protein lbs.	Carbohydrates lbs.	Fat lbs.
Concentrates.			
Dent corn	7.8	66.7	4.3
Sweet corn	8.8	63.7	7.0
Corn and cob meal	4.4	60.0	2.9
Corn bran	7.4	59.8	4.6
Gluten meal	25.8	43.3	11.0
Germ meal	9.0	61.2	6.2
Grano-gluten	26.7	38.8	12.4
Hominy chops	7.5	55.2	6.8
Gluten feed	20.4	48.4	8.8
Wheat	10.2	69.2	1.7
Wheat bran	12.2	39.2	2.7
Wheat shorts	12.2	50.0	3.8
Wheat middlings	12.8	53.0	3.4
Rye	9.9	67.6	1.1
Rye bran	11.5	50.3	2.0
Rye shorts	11.9	45.1	1.6
Barley	8.7	65.6	1.6
Brewers' grains, wet	3.9	9.3	1.4
Brewers' grains, dried	15.7	36.3	5.1
Oats	9.2	47.3	4.2
Oat feed or shorts	12.5	46.9	2.8
Oat dust	8.9	38.4	5.1
Oat hulls	1.3	40.1	0.6
Buckwheat bran	7.4	30.4	1.9
Buckwheat middlings	22.0	33.4	5.4
Flax seed	20.6	17.1	29.0
Linseed meal, old process	29.3	32.7	7.0
Linseed meal, new process	28.2	40.1	2.8
Cotton seed	12.5	30.0	17.3
Cotton-seed meal	37.2	16.9	12.2
Cotton-seed hulls	0.3	33.1	1.7
Peas	16.8	51.8	0.7
Soy beans	29.6	22.3	14.4
Cow peas	18.3	54.2	1.1
Horse beans	22.4	49.3	1.2

DIGESTIBLE NUTRIENTS IN 100 LBS.

	Protein lbs.	Carbohydrates lbs.	Fat lbs.
ROUGHAGE.			
Fodder corn, green	1.0	11.6	0.4
Fodder corn, field cured	2.5	34.6	1.2
Corn stover, field cured	1.7	32.4	0.7
FRESH GRASS.			
Pasture grasses (mixed)	2.5	10.2	0.5
Kentucky blue grass	3.0	19.8	0.8
Timothy, different stages	1.2	19.1	0.6
Orchard grass, in bloom	1.5	11.4	0.5
Redtop, in bloom	2.1	21.2	0.6
Oat fodder	2.6	18.9	1.0
Rye fodder	2.1	14.1	0.4
Sorghum	0.6	12.2	0.4
Meadow fescue, in bloom	1.5	16.8	0.4
Hungarian grass	2.0	16.0	0.4
Green barley	1.9	10.2	0.4
Peas and oats	1.8	7.1	0.2
Peas and barley	1.7	7.2	0.2
HAY.			
Timothy	2.8	43.4	1.4
Orchard grass	4.9	42.3	1.4
Redtop	4.8	46.9	1.0
Kentucky blue grass	4.8	37.3	2.0
Hungarian grass	4.5	51.7	1.3
Mixed grasses	5.9	40.9	1.2
Meadow fescue	4.2	43.3	1.7
Soy bean hay	10.8	38.7	1.5
Oat hay	4.3	46.4	1.5
STRAW.			
Wheat	0.4	36.3	0.4
Rye	0.6	40.6	0.4
Oat	1.2	38.6	0.8
Barley	0.7	41.2	0.6
FRESH LEGUMES.			
Red clover, different stages	2.9	14.8	0.7
Alsike, bloom	2.7	13.1	0.6
Crimson clover	2.4	9.1	0.5
Alfalfa	3.9	12.7	0.5
Cowpea	1.8	8.7	0.2
Soy bean	3.2	11.0	0.5
LEGUME HAY AND STRAW.			
Red clover, medium	6.8	35.8	1.7
Red clover, mammoth	5.7	32.0	1.9

DIGESTIBLE NUTRIENTS IN 100 LBS.

	Protein lbs.	Carbohydrates lbs.	Fat lbs.
Alsike clover	8.4	42.5	1.5
White clover	11.5	42.2	1.5
Crimson clover	10.5	34.9	1.2
Alfalfa	11.0	39.6	1.2
Cowpea	10.8	38.6	1.1
Soy-bean straw	2.3	40.0	1.0
Pea-vine straw	4.3	32.3	0.8
SILAGE.			
Corn	0.9	11.3	0.7
Clover	2.0	13.5	1.0
Sorghum	0.6	14.9	0.2
Alfalfa	3.0	8.5	1.9
Grass	1.9	13.4	1.6
Cowpea vine	1.5	8.6	0.9
Soy bean	2.7	8.7	1.3
Barn yard millet and soy bean	1.6	9.2	0.7
Corn and soy bean	1.6	13.0	0.7
ROOTS AND TUBERS.			
Potato	0.9	16.3	0.1
Beet, sugar	1.1	10.2	0.1
Beet, mangel	1.1	5.4	0.1
Flat turnip	1.0	7.2	0.2
Rutabaga	1.0	8.1	0.2
Carrot	0.8	7.8	0.2
Parsnip	1.6	11.2	0.2
Artichoke	2.0	16.8	0.2
MISCELLANEOUS.			
Cabbage	1.8	8.2	0.4
Pumpkin, field	1.0	5.8	0.3
Pumpkin, garden	1.4	8.3	0.8
Prickley comfrey	1.4	4.6	0.2
Rape	1.5	8.1	0.2
Dried blood	52.3	.0	2.5
Meat scrap	66.2	.3	13.7
Beet pulp	0.6	7.3	...
Beet molasses	9.1	59.9	...
Cow's milk	3.6	4.9	3.7
Cow's milk, colostrum	17.6	2.7	3.6
Skim milk, gravity	3.1	4.7	0.8
Skim milk, centrifugal	2.9	5.2	0.3
Buttermilk	3.9	4.0	1.1
Whey	0.8	4.7	0.3

PURDUE UNIVERSITY

Agricultural Experiment Station

CIRCULAR NO. 14.

LaFayette, Ind., July, 1908.

BEEF PRODUCTION.

III.

FACTORS INFLUENCING THE VALUE AND COST OF FEEDERS.

J. H. Skinner and W. A. Cochel.

The production of cattle which will return a profit both to the producer and the feeder, is a problem which deserves careful attention. It is easily possible to buy cattle which have been produced at a loss and fatten them at a profit, but the aim of the most thoughtful and intelligent men engaged in the beef cattle business is to encourage the production of a grade of cattle which will return a profit when sold as feeders without diminishing the profits in finishing them. In producing such cattle the particular system to be followed should be determined by the size, location and adaptability of the farm. One farm may be especially adapted for the production of feeders, another for the production of yearling beef and still another, only for finishing cattle.

In many sections of Indiana there is an abundance of rough land suitable only for grazing. Under such conditions the production of feeders should prove profitable by grazing them in summer and carrying them through the winter on cheap roughage such as clover hay, silage and straw, thus producing 1,000 to 1,200 pound feeders at a minimum cost and a reasonable profit. In other sections where the proportion of grazing to farming land is about equal, it is possible to both grow and fatten steers at the same time, marketing them as 1,000 to 1,200 pound prime yearlings. In still other sections where all of the land is suitable for growing corn and much of it is too valuable for permanent pasture, a different system may be followed by purchasing feeders and finishing them for market.



No. 1. Rough, broken land suitable only for grazing. The production of feeders should be profitable. These cattle were used in experiments conducted at the Station during the winter of 1907-08.



No. 2. Level, arable land, all adapted to grain growing; considered too valuable to keep in permanent pasture. The production of yearling beef, or finishing cattle for market should be profitable. Fifteen steers selected from this bunch won first prize and championship in "Short-fed Special" classes at 1907 "International."

The producer's profit depends upon the breeding, type and quality of the steers, the rate and cost of gain, cost of pasture and feed, the kind of ration fed, the condition of the steers when sold, and the manurial value of the feeds used. The feeder's profit depends upon the margin between the cost of feeders and selling price of fat cattle, the quality and type of steers, their previous treatment and condition when placed in the feed lot, the rate and cost of gain, degree of finish when marketed, value of manure produced, kind of ration fed, and gain on hogs following.

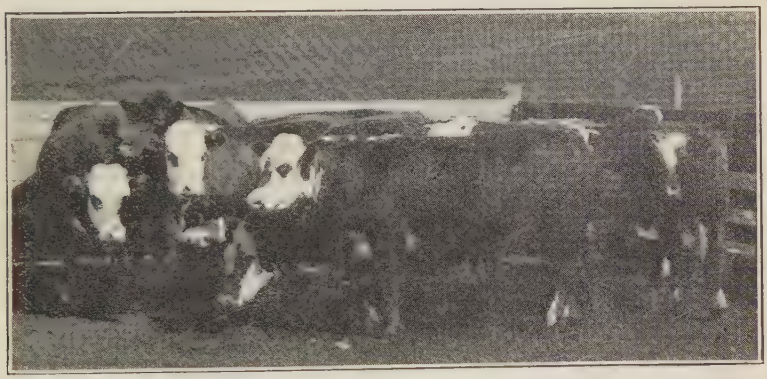
It is of vital importance to the producer to be able to appreciate the factors which influence the value of feeders in order to make the maximum profit from the business. It is essential that he recognize good and bad features in order to select, breed and produce what is wanted by the feeder. It is of importance to the feeder to have a knowledge of what determines the market price and value of different grades of feeders in order that he may buy the kind of cattle which are relatively the cheapest at the time of purchase. The chief aim in producing or in feeding beef cattle is to turn large quantities of grain and roughage into a more profitable product, to maintain soil fertility and to increase the yield of crops from year to year. The successful beef cattle producer or feeder must of necessity be a good farmer and, in addition, have the business ability and the knowledge of breeding, feeding and management of livestock, to derive two profits; one from growing farm products, the other from feeding them on the farm. Regardless of the system followed, whether it be the production of feeders or finishing cattle, a knowledge of the factors which control the cost of feeders, is of vital importance.

These factors may be arranged into two distinct groups; one inherent in the individual, which causes one grade of cattle to bring a higher price per hundred weight than another; the other, depending on financial or industrial or market conditions and influencing all grades. The group of factors which influences the prices of various grades of cattle is as follows:—

1. **Type or conformation.**
2. **Quality and breeding.**
3. **Age.**
4. **Condition.**
5. **Weight.**

Type. A typical beef steer is blocky and compact; has a short, deep body, short, thick neck, short, straight legs, straight back and underline, an abundance of width from one end to the other, plenty of scale and a "feeder's head and eye." The skilled feeder buy-

er pays much more attention to the head than the inexperienced buyer would deem necessary, especially with stock cattle, which are not filled out sufficiently to judge as to their future development and probable form when finished. He will also realize at first glance whether or not the eye is one that indicates a quiet and contented disposition.

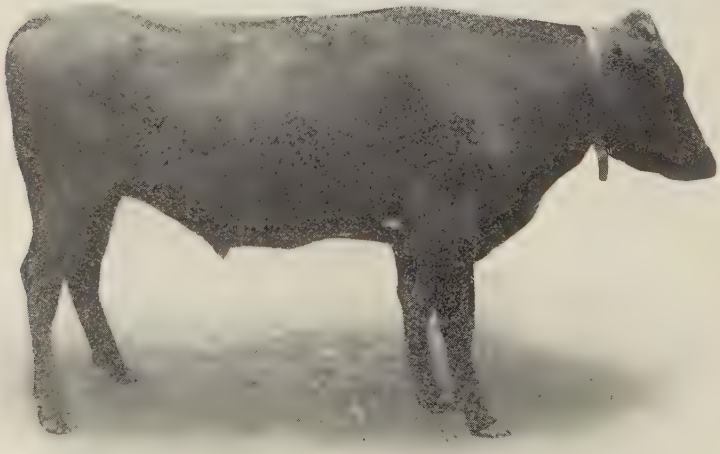


No. 3. Typical beef steers which returned a profit both to the producer and to the finisher. These cattle were fed as yearlings at the Station during the winter of 1906-07. Cost $4.15 per hundred. Daily gain per head for six months, 2.37 lbs. Selling price $6.00 per hundred.

The head should be broad, short, with full forehead, strong jaw, large mouth and nostrils, and free from either coarseness or delicacy. If such a head is found on a steer in feeder condition, it is usually a guarantee that he will make good use of feed and develop into a thick, blocky individual when finished. A thick, short neck is desirable, not because of its intrinsic value but because it usually indicates a thick carcass.



No. 4. An ideal feeder's head. A feeder of blocky, early maturing type, which will finish into a prime steer weighing 1075 lbs. at 15 months of age. Fed at the Station as a calf during the winter of 1907-08. Daily gain for six months 2 lbs.



No. 5. A steer of inferior type fed at the Station during the winter of 1905-06. Notice lack of constitution; long narrow head, long neck, rough shoulders, high flanks and poor back. Daily gain .77 lb. for six months.

A short, straight back indicates strong muscular development and a tendency to mature early. Other things being equal, the steer with the broadest and thickest back will be the most valuable as the highest priced cuts of meat are taken from the back and loin. For this reason, feeders should be selected which will develop wide, thick backs in order that they may sell for top prices when fat. A desirable depth of body and spring of rib, result not only in a greater proportion of high priced meat but also give the steer the capacity for a large development of vital organs and ample room for a large digestive system without any tendency to paunchiness.

Capacity for feed is essential in a feeder as the body must be maintained and provided with heat and energy before any of the food is stored in the form of fat. All that the steer can consume, digest and assimilate above maintenance requirements, is used for production; hence the greater the capacity, the greater the proportion of feed that is utilized for production and the less for maintenance.

Short, straight legs, together with a short, deep, broad body, are associated with early maturity. This is desirable from the producer's standpoint as it enables him to market his cattle as feeders weighing 1,000 pounds at 18 to 20 months instead of keeping them a year longer in order to attain the same weight. The early maturing steer will also sell for a greater price per pound, as the experienced feeder has learned that they will not only make rapid and economical gains but will finish quicker than those which are slower in maturing. Not only is this type more desirable to the producer and to the feeder, but also to the packer, as the early maturing kind yield a higher dressing percentage, thicker cuts and greater proportion of high priced meat.



No. 6. Capacity and type combined. A fleshy feeder suitable for short, heavy grain feeding. The "staggy" head and coarseness are undesirable. Fed at the Station during the winter of 1906-07. Daily gain for 90 days, 3.20 lbs.



No. 7. Steer No. 34 showing no capacity for feed. Daily gain 1.65 lbs. for six months. Fed in the same lot as the grade Shorthorn steer illustrated on page 17 of this Circular, which made 3.08 lbs. daily during the same period.

Quality. In the stocker or feeder, quality is synonymous with capacity and early maturity. It is indicated by a thick, fine, bright or oily coat of hair, a fine, hard dense bone, and an appearance of refinement, smoothness and symmetry throughout. Such a coat as described is generally associated with a healthy, pliable and mellow skin; as the inner digestive organs are continuations and modifications of the outer skin, health in one usually indicates health and activity in the other, insuring a good use of food and rapid gains. Smoothness and symmetry, together with quality and beef type shorten the fattening period. As the gains in the feed lot are expensive, this is an important factor in favor of the steer which possesses quality.



No. 8. High grade Hereford. "Quality" in a feeder is synonymous with capacity. This type can be fed at any age and it pays to make them prime. Fed as a yearling at the Station. Daily gain for six months 2.63 lbs.

Not only should a great deal of attention be given to quality in feeders because it insures less expense in finishing, but it enhances the value of the finished or fat steer. Quality in fat steers when combined with beef type, means higher dressing percentage, even covering of fat on carcass, large proportion of high priced cuts, better mixture of fat and lean, or marbling of meat, less waste in cutting and finer muscular fiber, all of which make the steers with



No. 9. A prime high grade Angus. Quality and finish in fat steers mean high dressing percentage and attractive carcasses. Daily gain for six months, 2.40 lbs.

quality more valuable to the killer than those which are plain and coarse.

Breeding. The question of breeding is not easily separated from that of quality and type as these can only be secured by the intelligent use of pure bred and registered beef bulls of good quality and approved beef conformation. A critical survey of the native stockers and feeders of the state shows that the importance of producing good cattle is not generally appreciated. It would be easily possible to increase the value of the native Indiana beef cattle $1.00 per hundred weight if proper attention were paid to the selection and use of breeding bulls. There are 1,141,778 cattle, other than milk cows, in the state.* An increase of $1.00 per hundred weight in value would be $8,563,225, assuming an average weight of 750 pounds per head. It is frequently stated that the Indiana farmer cannot compete with the western man who produces cattle on cheap land. This is true unless he either produces better cattle or uses a more profitable method of handling them. The majority of Indiana feeders go to central markets to buy feeders because they can secure

*Year Book, U. S. Department of Agriculture, 1906.

Two illustrations showing the effect of good breeding.



No. 10. Six steers sired by pure bred beef bulls. Average daily gain per head 2.64 lbs. for six months.



No. 10a. Four steers sired by grade bulls fed in the same lot as those in the preceding illustration. Daily gain 2.13 lbs. for six months, showing a difference of 24% in favor of the use of well bred steers or $5.50 per head when fat cattle sell at $6.00 per hundred.

steers of more uniformity and better breeding* although they readily admit that native cattle, if equal in other respects, are better than can be purchased in the yards.

In buying feeders, the breed is not of so great imporance as the individual, but preference should always be shown for uniformity in color, weight, age, condition, quality and type in a car load of feeders.



No. 10b. Southern Indiana steers produced by the use of pure bred sires through a series of years. These steers made an average gain of 420 lbs. per head in a six months feeding period while other cattle of unknown breeding made an average of 350 lbs. under similar treatment, a difference of 70 lbs. to the steer. This difference in gain on 35 cattle while in the feed lot would justify the producer in using a $200 bull rather than a scrub at $50. There would be a further profit due to the higher value per pound of such cattle.

*Circular No. 12, "Methods of Beef Production."

When such a load of high grade beef steers are put in the feed lot and properly fed, the result will be a more rapid and a cheaper gain, a quicker finish, a greater increase in value per hundred, a higher dressing percentage, a greater proportion of high priced cuts, a better quality of meat, less loose fat and a higher price when sold, than if a mixed lot of scrubs were fed.



No. 11. High grade Herefords showing uniformity in type, condition and color due to the use of pure bred sires.

Uniformity can only be secured in producing feeders by selecting and sticking to one breed through a series of years, placing especial emphasis on individual excellence, and by the use of pure bred and registered bulls of good conformation, on cows which possess at least a fair degree of beef type.* There are four or five leading breeds of pure bred beef cattle, all of which are bred with the same end in view, viz., to produce early maturing animals that have the constitution and capacity to stand heavy feeding and that are capable of making rapid and economical gains, finishing quickly, and when fat, yielding the highest grade of beef. In addition to these points, there are a number of breed characteristics which are of value in a breeding herd but of minor importance in the feed lot.

The greatest improvement in cattle in any community has only been secured by the use of pure bred beef bulls. A sire should get 30 calves per year for at least five years. If the value of his calves

*Circular No. 8, "Purchasing Feeders."

is increased $1.00 per head, this would amount to $150.00 during his period of usefulness. It is apparent that such an increase is easily possible as it would only amount to an increase of 10 cents per hundred on the 1,000 pound feeder.

In other words, an increase of $1.00 per head on the calves would overbalance the difference in price between a $50.00 scrub bull and $200.00 beef bull of excellent type and breeding.

Assuming that the cost of gains and the amount of increase in live weight are the same on two steers weighing 1,000 pounds, each when put on feed, one of which cost $4.00 per hundred and the other $5.00, the difference in price being due to breeding, the margin between buying and selling price necessary to break even in feeding well bred steers will be smaller than in feeding common or cheaper grades, as shown by the following exhibit:



No. 11a. High grade Angus steers showing uniformity in type, quality and finish. A profit to the producer and feeder.



No. 12. Mixed lot of "scrub" steers. Too many of this kind are produced in Indiana. They always insure loss to the producer and frequently to the feeder.

	Scrub Steer	High Grade Steer
Original weight	1,000 lbs.	1,000 lbs.
Original cost	$40.00	$50.00
Increase in feed lot	400 lbs.	400 lbs.
Cost of increase	$30.00	$30.00
Final weight of steer	1,400 lbs.	1,400 lbs.
Total cost of finished steer	$70.00	$80.00
Selling price per cwt.	$5.00	$5.71
Increase in value necessary to feed without profit or loss	$1.00	$.71

In this instance the margin between buying and selling price has to be $1.00 per hundred on the scrub as compared with 71 cents on the high grade steer. To illustrate this point more fully, if it cost $7.50 per hundred to put gains on each steer, the difference between the original cost and the cost of increase per hundred pounds live weight on the scrub steer would be $3.50 while on the



No. 13. Steer No. 48, sired by grade bull, in "feeder" condition.



No. 13a. Steer No. 48, sired by grade bull, after having been fed for six months. Daily gain, 1.54 lbs.



No. 13b. Steer No. 35, sired by pure bred bull, in "feeder" condition.



No. 13c. Steer No. 35, sired by pure bred bull, after being fed six months. Daily gain, 3.08 lbs. Notice how much greater the improvement is on the high grade steer while in the feed lot.

high grade steer it would be $2.50 per hundred. This would be recovered by a margin of 32 cents on the scrub steer or 23 cents per hundred on the high grade steer. It is also true that well bred cattle will require less feed per pound of gain, make gains more rapidly and take less increase in weight to put them in the same condition. It frequently happens, however, that scrub cattle in thin condition can be bought so cheaply that they can be finished at a profit. This means a loss to the producer with a profit to the feeder.



No. 14. Common rough steer, a loss to the producer but a profit to the feeder. Gain in 90 days, 291 lbs. If well bought, and marketed at the right time, such steers may be fed at a profit.

Condition. There is a distinction between *condition* and *weight*, which is frequently overlooked by the practical cattle feeder. Condition, in connection with feeders, means the degree of fatness. Other things being equal, the higher the condition of cattle going into the feed lot, the greater will be the profit to the feeder. The feeder buyer can afford to pay more for fleshy feeders because they require a shorter feeding period to finish and are usually more thrifty than thinner cattle which have had an equal opportunity.

It is generally recognized that the gains on cattle while in the feed lot being finished for market are quite expensive, which is an-

other reason for a greater price being paid for fleshy cattle. This may be illustrated by the following exhibit:

1,000 lb. steer @ $4.00	$40.00
100 lbs. increase in feed lot @ $7.50	$7.50
Total cost of 1,100 lb. steer	$47.50
Total cost per hundred	$ 4.32

It can be readily seen that the same steer when weighing 1,100 pounds would have cost the feeder $4.32 per hundred as compared with $4.00 per hundred when weighing 1,000 pounds. The producer is generally so situated that he is able to secure this higher condition at much less expense than is possible in the feed lot, and frequently at less than its selling value per hundred. Under such conditions he should endeavor to hold his cattle until they may be marketed as "fleshy feeders" in order to obtain the additional premium paid for this grade of cattle.

Weight. The heavier the feeder, the greater will be the profit from the margin between the cost of feeders and the selling price of fat cattle. The poorer the quality the more important it is to have weight at the beginning of the period. Assuming that two lots of cattle of the same age, type, breeding, condition and previous treatment, are offered at $4.00 per hundred, one lot weighing 1,000 pounds, the other 1,200 pounds, a rise in value of $1.50 per hundred while being finished would amount to $15.00 on the 1,000 pound cattle and $18.00 on the 1,200 pound cattle, a difference of $3.00 per head in favor of the heavier cattle, due to additional weight alone. If this additional weight were due to condition rather than size, there would be a further profit due to either a shorter feeding period or a higher price when sold.

Age. The question of age is one that has attracted much attention. The younger the steer, provided weight, condition and quality are the same, the more valuable to the feeder, as the cost of gain increases with the age of the cattle. In selecting calves which are to be finished as yearlings, the greatest attention must be paid to secure quality, type and breednig as it is impossible to finish inferior cattle at an early age. Calves taken directly from their dams and weighing from 350 to 500 pounds will bring more per pound than they will any time later until they are fat enough to be attractive to the kil'er. A greater price may also be paid per pound for well bred calves which are to be carried as stockers than for lower grades. A difference of 50 cents per hundred on the price of a 400 pound calf will amount to $2.00. When weighing 1,000 pounds this would be overcome by an increase of 20 cents per hundred, which is easily secured with a very little better breeding and more quality. In other words, the calf buyer is justified in paying for quality and indica-

tions of early maturity whether he intends to carry them as stockers or put them in the feed lot immediately.

General Conditions Influencing the Price of Feeders.

The other group of factors influencing the cost of feeders, is neither under the control of the producer or of the feeder but is determined by the general financial and industrial condition of the country together with trade and market conditions. The feeder market depends upon supply and demand, hence any condition which affects the outlet for beef cattle, of necessity has a decided influence on prices. This second group of factors is as follows:

1. **The locality.**
3. **Season of the year.**
3. **Price, condition and supply of corn.**
4. **Supply of roughage.**
5. **Condition of the market for fat cattle.**

Locality. In certain sections of the country where there is an abundance of rough land, capable of producing blue grass, clover and other pasture grasses in abundance, and well supplied with good water, the production of feeders can be successfully followed. When such grazing land is available in large quantities there is usually a scarcity of tillable land to produce enough corn and other grains to finish cattle at a profit, hence the most logical procedure for the producer in such a section is to market cattle as feeders. Investigation has shown that southern Indiana is especially adapted to this method of beef production. These cattle are usually shipped to central markets, *hence their home value is determined by their market price, less the expense incident to shipping, such as freight, commission, feed and yardage. In the grain growing sections of the country, the cost of feeders is determined by their price at central markets with the additional expense incurred in shipping them to the feed lot. In this way the locality in which the cattle are produced may influence the price of feeding cattle 50 cents per hundred or more, depending upon the local supply and demand and the distance from a central market.

The Season of the Year. It is well known that the season of the year has a decided influence on the cost of feeders. In the fall when there is an abundant supply of cattle going to market in all degrees of condition from grass fat to thin stockers, the feeder has a wide selection and an abundance of material from which to draw. A large supply of cattle at this time of the year, together with the approaching winter when the feeds will be more expensive and the gains less rapid, reduces the price. In the spring there is a strong demand for feeders due to the approach of a favorable feeding season and to the scarcity of cattle with flesh enough to be classified as feed-

*Circular No. 8, "Purchasing Feeders."

ers. At this time the packer or butcher has exhausted the supply of cheap beef which was put up during the summer season and is on the market for the class of cattle most desirable for feeding purposes. If the feeder bids against him, he necessarily has to pay more than he does in the fall when there is a larger number of cattle going on the market from which to select. This has caused a large number of cattle feeders to buy stockers in the fall at comparatively low prices, carry them through the winter in stalk fields, on wheat and oat straw, corn fodder and other cheap, rough feeds, with little grain and a minimum amount of care and attention. If stockers maintain their weight under such conditions during the winter, the owner is usually satisfied.



No. 15. A lot of high grade Herefords 12 months of age, fed at the Station during the winter of 1906-07. Average daily gain for six months 2.08 lbs. per head. These cattle sold in Chicago at $6.75 per hundred, August, 1907, the highest price paid during that year for cattle weighing under 1000 lbs. per head.

There is also in the spring a strong demand for stockers suitable for grazing. Summer gains are usually cheap as stockers will put on from 250 to 350 pounds during the six months grazing period, if not started on the grass in too high a condition. At ordinary rental for pasture, this gain will cost from 2 to 3 cents per pound, hence a greater price per hundred can be paid for steers in the spring of the year than in the fall. This may be shown by the following explanation. Cattle weighing 700 pounds in the spring when turned on grass and costing 5 cents, should gain 300 pounds during the summer without grain. This will cost, with pasture at $1.00 per month per head, 2 cents per pound, thus the same cattle weighing 1000 pounds at the close of the grazing season, will have

cost $41.00 per head. This includes $35.00 for the original cost and $6.00 for grazing. Thus it will be seen that they could be sold at $4.10 per hundred or 90 cents per hundred cheaper in the fall than in the spring without profit or loss.

During nearly every summer there is a drought in some large section of the country where the chief source of revenue is from cattle which are carried to utilize grass. When such a drought occurs over a large area of land, there is a shortage of feed so that cattle which would otherwise have been carried through, are rushed into market, making an over supply or glut which necessarily reduces the price of feeders. In other years there may be an abundance of grass throughout the season which holds back the cattle that would have come on the market regularly during the summer, until late in the fall.

Supply and Price of Corn.

The supply and price of corn in the fall of the year largely determine the price of feeders. In other words a large crop of corn selling from 30 to 40 cents per bushel, necessarily means increased prices for feeders, due to a strong demand. If the supply of corn is so short that the price is advanced materially, there is a corresponding decrease in the demand for feeders. At the same time there will be many who had intended to feed their cattle that will ship them to market to avoid the necessity of feeding high priced corn. This causes an abnormal supply, which, taken with the decreased demand, insures a large supply at a low cost. When there is a large corn crop selling at low figures, the small feeder who handled from one to two car loads of cattle, is much more apt to venture into the cattle business than he would with corn at 50 cents per bushel. When the corn crop is not in marketable condition, there is a further incentive to feed cattle in order to convert it into beef and pork. This may in some instances cause so great a demand for feeding cattle as to overbalance the depressing influence of high priced corn. It may be generally stated that exceptionally high priced corn, in good marketable condition, causes a weak market, while a larger crop, or one not in marketable condition, causes a strong market for feeders.

The Supply of Roughage.

The supply of roughage is another determining factor in the price of feeders. There is a demand for fleshy steers suitable to go on full feed of corn quickly, in seasons such as the past two years (1906-07) when clover has been a failure and a comparatively small amount of rough feeds is available. This in a measure, causes the thinner sorts of cattle to be discriminated against. If, on the other hand, there is a large crop of clover and other roughage with a small supply of grain, there is as great a demand for stockers as for feeders. When the supply of both grain and roughage is abundant,

there is a greater tendency to buy stockers to consume roughage and feeders to consume the grain.

Condition of the Fat Cattle Market.

If there is a wide outlet for beef and a small supply, causing fat cattle to sell at high prices, many are encouraged to feed cattle who would otherwise not do so. Experienced cattle feeders consider that there should be an increase of from 20 to 30 cents per hundred per month on cattle while fattening, in order to insure a profit. When fat cattle are selling from $6.50 to $7.50 per hundred, feeders should apparently be worth $1.00 more per hundred than if the fat cattle market is on a basis of $5.50 to $6.50. As a general rule however, it may be said that the experienced cattle feeder who is in business continuously from one year to another, is disposed to avoid buying feeders when fat cattle are selling at extremely high prices. He also avoids buying feeders during periods of high prices and prefers to wait until an opportune time which occurs every year, when they sell at normal prices. Too frequently the beginner starts in the business when prices are inflated and is compelled to market his cattle when a reaction has taken place.



No. 11b. First prize and champion "Short-fed Special" cattle shown by Purdue Experiment Station at "International" 1907.

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 15.

LaFayette, Ind., May, 1909.

GROWING ONIONS FROM SEED.

J. Troop. C. G. Woodbury.

There are in northern Indiana, many hundreds of acres annually devoted to the growing of onions from seed. It is the purpose of this circular to discuss briefly the methods employed in growing, harvesting and marketing the crop, as these operations are carried on in the locality mentioned. Especial attention is given to those phases of the business concerning which there is the greatest demand for information among the growers, and in some instances improvements in present practices are suggested which may result in making the crop more certain and more profitable.

The bulk of the commercial onion crop is produced in the northern four tiers of counties, Noble and Kosciusko counties usually leading in acreage. The total area devoted to the crop varies roughly between 3500 and 5000 acres. Nappanee, Kendallville, Wolf Lake, Churubusco, Kimmel and Albion are some of the principal shipping and producing centers.

Soil. The land used for commercial onion growing is principally black muck, and in most instances has been reclaimed

by draining the swamps. Not many years ago this muck was considered to be practically worthless, but now good onion land frequently brings $150 per acre. This muck consists almost entirely of organic matter and usually analyzes about two or three per cent. nitrogen. Although phenomenally rich in this element of plant food, the productivity of this soil without fertilizer is not so great as might be expected, since a large proportion of the nitrogen exists in a form in which it is not available to plant life, and moreover on this type of soil, potassium, another element essential to plant growth, is generally very deficient. In physical appearance the muck soil is very black and very fine. It varies in depth from three or four feet to six or eight feet and is quite uniform in composition. The sub-soil, however, is variable. Those muck lands which have supported an original growth of timber, or which are underlaid by a clay sub-soil are said to be superior to those on which the original growth was only brush or those which are underlaid by sand and gravel. Doubtless the water holding capacity of the soil, and the constancy of the water table have much to do with this superiority.

In order to grow onions satisfactorily, it is necessary that the soil be well drained. If the water comes to within a few inches of the surface or stands upon it for even a few days, the crop is almost certain to be a failure in that spot.

There is considerable variation in the opinions of commission men, as to the effect of the muck soil on the quality and texture of the onion. From most of the leading onion markets of the country, the report is that Indiana onions are equal in quality to those grown in any other locality. A few consider that the crop as grown on heavier and more elevated soils or on sand, is firmer in texture and of better keeping quality. It is probable that the seasonal variation is as great as that caused by different types of soil.

FITTING AND FERTILIZING.

The seed bed.—The land for onions is plowed in the spring rather deeply. On heavier classes of soil it is often an advantage to have the plowing done in the fall. This is followed by thorough harrowing, and later the ground is usually gone over with a float or plank drag and finally rolled. The object is to form as fine a seed bed as possible. With the muck soil this is generally not very difficult. It is essential, however, that the land be thoroughly fitted and that a fine smooth bed be prepared for the seed if the plants are to make satisfactory growth.

Fertilizers.—There is considerable variation in the kind and amount of fertilizer used in growing the onion crop. Barnyard or stockyards manure is a standby with many growers, and is one of the most popular and extensively used fertilizers. This is generally applied as a top dressing at the rate of several tons per acre and plowed under in the spring. The manure is supplemented with commercial fertilizers at the rate of 500 to 1000 pounds per acre, put on at seeding time or a short time previous to seeding, while the ground is being fitted. There is a disadvantage in the use of large quantities of barnyard manure which is sometimes overlooked. Its presence seems to encourage the development of the onion maggot, which in some localities is becoming a serious pest, and it also makes and keeps the land foul with weed seeds. The expense of growing the crop is dependent directly upon the amount of hand labor required. Hand weeding is one of the most costly items of cultivation, and anything which will reduce this expense should be considered.

There is not very much experimental data at hand as to the fertilizer requirements of onions on muck soil. From analyses* of Yellow Danvers bulbs, it has been found that they contain .225 per cent. nitrogen, .086 per cent. phosphoric acid and .217 per cent. potash. In northern Indiana a very good but not exceptionally high yield is 800 bushels per acre. The above analysis would indicate that a crop of this size, figuring 56 pounds to the bushel, would

*New York State Experiment Station, Bulletin No. 265.

remove from the soil over 100 pounds of nitrogen, about 35½ pounds of phosphoric acid and 97 pounds of potash. Although the differences in season, in amount of rainfall, etc., make too much variation for us to state directly what fertilizer pays best simply from analysis of the plant, yet it is possible in this way to get a general idea of what is needed if we take into consideration the particular type of soil we are dealing with. Voorhees* recommends for onions the application of 1000 pounds per acre of a fertilizer containing five per cent. nitrogen, six per cent. phosphoric acid and ten per cent. potash, with later dressings of nitrate of soda or sulphate of ammonia.



Photo by C. G. Woodbury.

Fig. 1. These two lots of onions are exactly the same age and grew within 30 feet of each other in same field. At left, fertilizer had been applied between the rows; at right, under the row.

In northern Indiana many growers simply buy according to price without heed to the amount or condition of the plant food elements in the fertilizer. Many, on the other hand, study the needs of the soil and buy fertilizers accordingly. Following are some of the brands of fertilizer which are frequently used, together with their guaranteed analyses in 1908.**

*"Fertilizers" by Edward B. Voorhees, A. M.
**Purdue University Agricultural Experiment Station, Bulletin No. 125.

	Per cent. nitrogen (N)	Per cent. potash (K_2O) soluble in water	Per cent. soluble and reverted phosphoric acid	Per cent. insoluble phosphoric acid
Banner Brand Armour Fertilizer Works, Chicago, Ill.		8.0	10.0	
High Grade Potato Armour Fertilizer Works, Chicago, Ill.	1.6	10.0	8.0	
Atlas Onion Grower Atlas Fertilizer Co., Ft. Wayne, Ind.	1.5	8.0	8.0	1.0
Atlas Onion Special Atlas Fertilizer Co., Ft. Wayne, Ind.	2.0	5.0	6.0	1.0
Bash's Onion Grower Bash Fertilizer Co , Ft. Wayne, Ind.	1.5	8.0	8.0	1.0
Bash's Onion Special. Bash Fertilizer Co., Ft. Wayne, Ind.	2.0	5.0	6.0	1.0
Monarch Onion Grower. Monarch Fertilizer Co., Ft. Wayne, Ind.	1.5	8.0	8.0	1.0
Horse Shoe Brand Special Onion and Vegetable Manure Northwestern Fertilizing Co., Chicago, Ill.	0.8	10.0	5.0	2.0
Onion and Truck Fertilizer Wuichet Fertilizer Co., Dayton, Ohio.	1.5	8.0	8.0	1.0

It will be observed that the analyses of these fertilizers reveal the presence in most of them of a relatively small amount of nitrogen and of a relatively large amount of potash and phosphoric acid. The proportions undoubtedly represent in a rough way something near the relative amounts of plant food required by the onion crop grown on the muck soils of northern Indiana.

The muck soil as has been said, contains an abundance of nitrogen, hence it might be expected that not much nitrogen would need to be applied. This is true in a general way, but it must be con-



Photo by C. G. Woodbury.

Fig. 2. Type of hand weeder for use in earliest cultivation of onion crop; sometimes used before onions appear.

sidered that those agents in the soil which render the nitrogen available for plant use do not work very actively until the ground is thoroughly warmed and the season pretty well advanced, so that an application of nitrogen early in the season, which will be immediately available, is beneficial in giving plants an early and vigorous start.

The advantage of stockyards manure, while it is undoubtedly

a cheap source of plant food, is partially offset by the considerations before mentioned, of encouraging maggots and of bringing in weed seeds, so that it is a question whether so much dependence should be placed upon it as is the general practice at present.

The method, as well as the time and amount of the applications of fertilizer, must be taken into consideration. The onions need to have an early and vigorous start after being put in. If the fertilizer is so applied that it all falls between the rows, the crop is not able to utilize it early in the season when it is badly needed. A part at least should be put in the row under the seed so that the young plant may begin to derive advantage from it very soon after germination. A part on the other hand may be applied broadcast or between the rows in order to give the plant the benefit of it later in the season and to encourage a vigorous and continuous growth till ripening time.

Briefly summed up then, the most rational way to use fertilizer for onions on northern Indiana muck soils, would seem to be, from the evidence at hand, the use of 800 to 1000 pounds of a fertilizer containing one or one and a half per cent. nitrogen, six to eight per cent. phosphoric acid and about ten per cent. potash. The nitrogen present is probably sufficient for the needs of the plants early in the season, especially if some barnyard manure is used in connection. Results are being obtained with the "Banner Brand" which contains no nitrogen. By midseason, the nitrogen which is stored in such large quantities in the muck soil itself, is becoming available to the plants. On more sandy types of soil, a larger quantity of nitrogen might be advantageously used, two or three per cent. being used in the fertilizer, this possibly to be supplemented with an additional dressing early in the spring of 75 to 100 pounds of nitrate of soda. On either type of soil, part of the fertilizer should be put in the row and part broadcast or between the rows.

The varieties grown are almost wholly the globe types, Southport White Globe, Yellow Globe and Red Globe are the leading sorts.

The seed.—A few growers attempt to grow their own seed, but by far the largest part is supplied by commercial seed houses which make a specialty of the onion business. Rather heavy losses are not infrequent on account of poor seed. This may be due to the use of old seed since onion seed is comparatively short lived. What



Photo by C. G. Woodbury.

Fig. 3. Double wheel hoe and its work early in the season. By skillful use of this tool much hand weeding may be saved.

is probably more frequently the case, is that the seed has been exposed to some unfavorable conditions—that it has been allowed to become damp and partially germinated or has been exposed to too extreme and rapid fluctuations in temperature. The weather conditions at time of harvesting may also seriously affect the vitality. The seed should be thoroughly matured if it is to retain its

vitality for the maximum period. Duvel* states that—"seed harvested in damp, rainy weather is much weaker in vitality than seed harvested under more favorable conditions. Likewise seed once injured will never regain its full vigor." It has been proved that moisture is the principal factor in lowering the vitality of stored seeds. In order to retain vitality so that it will not only germinate but will make vigorous plants, onion seed must be kept *dry*.

Testing.—A large part of the growers' losses from poor seed might be obviated by testing. It is not so much the loss of the price of the seed that is important, though this is a considerable item on a 40 acre planting, but the delay from seed not coming after being put in the ground often means a lost crop for the season. The vitality of onion seed may be very easily tested by counting out a few hundred and placing them between moist cloths or blotting paper on a plate and putting in a warm place for a few days, then counting the number which have germinated. Sowing in the soil in a greenhouse is another good way, though considerably more trouble. If the vitality of the seed has been injured and slightly lowered, the test may show a larger percentage of living seed than there would be of vigorous plants in the fields. Nevertheless the house germinating test will give a very fair indication of what may be expected and after a few trials it is not difficult to judge the vitality of the seed by the promptness as well as by the percentage of the germination.

Seeding.—The seed is put in the open field as soon as all danger of frost is past and the ground is thoroughly warmed in the spring. In northern Indiana this brings seeding time from early in April to early in May, depending on the season. Nearly all the seeding is done with hand drills, the "Planet Jr." manufactured by the S. L. Allen Co. of Philadelphia, and the "Iron King" and "Excelsior" manufactured by C. W. Genung and Davet Bros. respectively, of Madison, Ohio, being the most popular. A few growers have rigged up special horse drills by means of which several rows may be seeded at a time. There would seem to be a good market for this sort of tool.

The seed is put in rows from 11 to 14 nches apart, and from

*U. S. Department of Agriculture, Bureau of Plant Industry. Bulletin No. 88.

three-fourths of an inch to two inches deep. Three-fourths of an inch is deep enough under ordinary conditions. The onion marshes are very flat, however, and the muck is fine so that if a few days of dry weather come, after the seed has been put in the ground and before the plants are up, and if the dry weather is accompanied by high winds, seed put only three-fourths of an inch deep is often blown out. On these large and unprotected marshes, a few low windbreaks to lessen the force of the wind at the surface of the ground, would be a decided advantage.



Photo by C. G. Woodbury.

Fig. 4. The first hand weeding. Active boys make the best help for this work.

The amount of seed sown varies with different growers and in different localities. From three to five pounds per acre is common for the red and yellow varieties, while rather more, from five to seven pounds may be used for the whites, so that the onions may not have opportunity to grow so large. The germinating power of the seed also helps to determine the amount used. The trade demands white globes of perfect shape, but not of too large size, while with the red and yellow varieties, large size seems to be no disadvantage.

Cultivation.—In all the operations connected with commercial onion growing, a large amount of hand labor is necessary. In nothing is this more true than in the cultivation of the crop which should begin soon after seeding. Although there may be considerable difference in two pieces of onion land in the amount of weed seeds it contains, yet there are always enough weed seeds, even in the cleanest land, to make necessary a constant and vigorous fight to harvest a crop. In keeping the land clean, prevention rather than



Photo by C. G. Woodbury.

Fig. 5. Evil results when hand weeding is too long deferred. The onion plants fall down and the weeds make cultivation difficult.

cure must be relied upon. So even before the expiration of the week or 10 days which must elapse before the plants begin to show through the ground and indicate the rows, it is a good plan to go over the field a couple of times with a hand weeder in order to stir the surface lightly and destroy the weeds which may be germinating. As soon as the onions are up, cultivation with the wheel hoe is begun and is kept up pretty constantly for several weeks thereafter, or until the crop shades the ground so that the weeds no longer have a



Photo by C. G. Woodbury.

Fig. 6. A field of young onions showing a good stand, uniform growth and ideal cultivation.



Photo by C. G. Woodbury.

Fig. 7. Onion harvest. The onions are allowed to cure slightly in the windrows and are then topped and stacked in field crates for further curing.

chance. Both the single and double wheel hoes are used, though the latter is the more popular design. The tool straddles the row and has two blades which are adjustable as to the width of row left and may also be set either to throw the earth to the row or away from it. The hoes are usually set to throw to the center during the early cultivation and to the row later in the season. The hilling is only very slight in any case, and the idea is to give practically level cultivation during the season. If the blades are not changed at all, the tendency is by repeated cultivating to either hill the rows or to throw too much away from the plants to the center. By reversing the blades, cultivation can be kept practically level. With a careful man, and with straight rows the space left for the row need not be early in the season, more than an inch and a half wide.

Hand weeding.—To keep down the weeds in the row, hand weeding must be resorted to. For this purpose small boys or girls are usually the best help obtainable, since they can go faster and pull the weeds with less work than men; also their labor is generally cheaper for the grower. The number and frequency of the hand weedings necessary, depend upon the season and on the foulness of the land. In a wet season or on foul land, of course more labor is required. It is extremely important here, as in all other onion cultivation, to keep ahead of the weeds. It costs less to keep the crop clean than to get it clean after a little neglect. The weeders go on hands and knees, and a row should be assigned to each individual. On some land it is desirable that the weeders wear some kind of a pad of burlap or other cloth over the knee, but on the typical muck soil this is not usually necessary. The weeders should be cautioned against leaving the white necks of the young plants exposed. If the weeds have been allowed to get a start, care is required not to injure the plants in removing them. If the weeds are allowed to become several inches tall, it not only costs much more to get them out, but the onion plants are certain to suffer, not only by being robbed of the plant food and by shading, but also by the removal of the earth from around them, a certain degree of which is unavoidable when the weeds are large. Moreover the weeds then make a mat between the rows and render subsequent cultivation with the wheel hoe much more difficult. Probably there is as much loss

and discouragement in onion growing resulting from failure to do the hand weeding soon enough and often enough, as from any other single cause. Many fields may be seen abandoned to the weeds by midsummer, which started out in good condition simply because the owner did not realize the extreme importance of keeping the weeders ahead of the weeds. After the onion plants thoroughly shade the ground and the tops are so large that they meet in the row, so that cultivation is impossible, they may be "laid by" until harvest.



Photo by C. G. Woodbury.

Fig. 8. Red Globes curing in the field. The crates are stacked, covered for protection from rain and allowed to cure in field for two to three weeks.

HARVESTING, STORING AND MARKETING.

In northern Indiana the crop ripens and harvesting begins any time from late in August to the first of October. The ripening of the crop can be determined by the falling down and withering of the tops. If ripening is very late, there is danger of difficulty and loss in curing on account of wet weather. If the harvesting is very much delayed after ripening, a secondary growth may begin, which makes harvesting more difficult and injures the quality of the crop.



Photo by C. G. Woodbury.

Fig. 9. Cleaning and grading. Before marketing, the onions are cleaned on a rack and the culls and outer skins removed. The White Globes are graded also according to size.

The methods of harvesting differ in many points, with different localities. They also differ considerably with varieties. The white globes required more careful treatment than the reds and yellows, as they are more easily injured by unfavorable conditions, are likely to be stained by the weather and yellowed by the sun, and are generally considered more hazardous to grow.

Harvesting.—The general method is that shown in figure 7. The onions are pulled by hand and eight rows thrown together in a winrow with the bulbs all one way or all towards the center. They may be left for a day or two in bright weather without injury, but if for a longer time than that, are piled so that the bulbs are protected from the sun by the tops. They are generally allowed to cure for a few days until the necks get fairly dry and are then topped and crated. Sometimes they are mature enough when pulled, to top at once. The topping is done by hand with sheep or lawn shears,



Photo by C. G. Woodbury.

Fig. 10. The collapsible Cummer crate for marketing fancy White Globes. For the smaller grades the crate is lined with cheesecloth.

an inch or slightly less of the neck being left on the bulb. Some large growers are using topping machines with good results. If topped in the fields they are crated at once and the crates stacked in single rank, six to eight tiers high. The stack of crates is then covered with building paper, tarpulin or rough boarding, to protect the onions from rain, and they are left in the field for two or three weeks longer to cure.

Instead of curing in the fields, many growers have curing sheds in which the crates are stacked under cover. This is quite necessary

in curing the white onions except under the most perfect weather conditions, and is frequently resorted to in curing the reds and yellows. Curing in sheds takes about two weeks longer than curing in the field. The sheds are built to give the greatest amount of ventilation consistent with protection. Frequently they are arranged with large doors hinged at the top and these are opened out wing-fashion and propped up. Another common type is a slat construction leaving one or two inch spaces between the strips which form the walls. In winter these structures are used to store the large number of crates used in harvesting.



Photo by C. G. Woodbury.

Fig. 11. Onion curing shed and storage barn.

After curing, the onions are sorted on sorting racks having a bed of slats one and a quarter inches apart, where the poor ones and "thick necks" are culled out, and where they are cleaned by the removal of the loosest outer skin. After this treatment, the reds and yellows are ready for market or for storage.

Storing in pits.—In some localities the procedure differs from the above description. After curing for the first few days in the field, they may be buried without topping. The storage pits in such

cases may be made as follows: a shallow flat trench is dug and ventilation provided at the bottom, by laying in the center an inverted trough of six-inch or eight-inch boards. Then a few inches of straw is put down either on the ground or on rough boards and the onions piled in a long rick. Sometimes side boards are used to make the pile higher and to protect the lower corners from the earth. A few inches of straw are put over the onions and a light layer of earth put over the straw to keep it in place. Ventilation is essential, and if so much earth is put over the straw as to entirely prevent ventilation, the onions are liable to rot. When the crop is marketed, the end of the pit is opened and the onions topped, sorted and bagged by men working at the end, uncovering more onions as they progress.

A large part of the onion crop is not marketed immediately after harvest, but is stored and disposed of gradually during the winter. Storage houses are of many different types, from simple bank barns in which a fire is kept to prevent freezing in extreme weather, to well constructed storage houses with walls containing layers of building paper and dead air spaces which keep an almost constant temperature during the storage period. The requisites of a good storage house for onions are that it be dry and so constructed, that a fairly uniform temperature may be maintained. Good ventilation, freedom from moisture, and uniformity of temperature are all important. Onions will stand considerable frost without injury and may be kept well even if frozen. If frozen they should be so protected that they remain so until ready to market, when they should be thawed out gradually. They should never be handled while frozen, as in this condition they are very easily bruised and injured.

Markets.—The market for northern Indiana onions is more or less variable. The localities to which they are shipped depend somewhat on the crop in other parts of the country. New York is nearly always a good market for white onions and picklers, and in seasons when the New York state crop is light, it is an excellent market for all sorts. When the New York crop is good, Indiana cannot compete on account of freight rates. This statement also holds for

Buffalo, Boston and most eastern points. Philadelphia furnishes a limited market for white onions and an excellent one for yellows. Some of the overgrowns and roughs find their way to St. Louis. In most southern cities, especially where the negro is an important element in the consuming population, the red onions find a readier market than the yellows. This is true of St. Louis, New Orleans, Memphis, Birmingham, Nashville, etc. In the northern cities such as Pittsburg, Cincinnati, Philadelphia, Washington, Baltimore, Cleveland, Detroit and Toledo, the demand is stronger for the yellow varieties.



Photo by C. G. Woodbury.

Fig. 12. Commercial grades and sizes of White Globes from picklers to overgrowns.

Red and Yellow globes are shipped either in bulk or sack. The amount per sack varies considerably with the different markets; 70, 75, 80, 85, 100 and 140 pound sacks being preferred in different places. In buying and selling, 56 pounds is usually considered a bushel, and prices are determined on this basis, though according to the Indiana law, 48 pounds constitute a bushel of onions. The White globes are marketed almost entirely in crates. A few of the roughs go in bulk but for the greater part of the crop, the Cummer crate is used, made by the Cummer Mfg. Co., of Cadillac, Mich. These crates cost 15 cents each in car-load lots.

COST OF GROWING.—YIELDS AND PROFITS.

The *cost* of growing, is, of course, a variable item and will depend largely upon the personality of the grower. Careful estimates of some of the best northern Indiana growers vary from $50 to $100 per acre for the whole cost of growing, harvesting and marketing the crop. Probably $75 is a fair approximation. One very successful grower reports $150 per week on a 25 acre field, from first hand weeding to harvest.

The *yields* with a fair season and good care run from 400 to 800 bushels per acre. One thousand bushels is sometimes reported. A record is claimed which seems to be well authenticated, of 1400 bushels per acre on a field of about five acres. This, of course, is very exceptional. Prices vary with the different seasons and with the time of year. White onions often bring $1.00 per bushel during the winter. Reds and yellows may reach 75 cents. They are more likely to run from 35 cents to 50 cents per bushel. At the time of writing, Chicago quotations on yellows are 50 cents to 55 cents per bushel, and 45 cents to 50 cents per bushel for reds.

The *profit* to be expected, of course, depends upon yield, price and cost of growing. It is generally poor economy to try to save expense in growing by not weeding thoroughly or by withholding fertilizers. Under favorable conditions, $100 to $250 per acre is often made. As one large grower expresses it, "It takes nerve and money to grow onions."

Maggot.—This insect is doing considerable damage to the onion crop in some localities in northern Indiana. The maggot which causes the injury is the larva of a fly, about one-fourth of an inch in length. The winter is generally spent in the adult stage, the fly hibernating in rubbish or in crevices under loose bark, and emerging in spring for egg laying. The egg is said to be about one twenty-fifth of an inch in length, oval in outline and white in color. It can be seen by the naked eye upon close examination. The eggs are deposited on the young plants or on the ground near by. The period of incubation is said to vary from four to 10 days. The newly hatched maggots make their way to the young plants and feed until full grown, when they leave the plant and form a pupar-

ium in the ground from which they emerge as adults in early summer. There may be several broods during the season.

Dr. Smith reports* carbolic acid and lime as the most effective material tested as a remedy for the maggot. The applications should be made weekly with great thoroughness, so that the surface of the soil about the plants is thoroughly coated. It is probable that the material acts as a repellant to the adult, as well as preventing the young from reaching their food supply if the eggs should be laid near the protected plants.



Photo by C. G. Woodbury.

Fig. 13. Effect of onion maggot in field. The tops wilt and the bulbs rot.

To make the material, slake *the lime to a thin cream. Use three pints to a gallon of water and to this add one tablespoonful of crude carbolic acid.

All infested plants should be removed and destroyed with the maggots in them as soon as discovered. As far as possible, land which has been infested during the season, should be planted to some other crop the next season rather than to onions.

*New Jersey Agricultural Experiment Station, Bulletin No. 200.

INDEX.

Page.

Acreage 1
Analyses of onion bulbs 3
Analyses of onion fertilizers 5
Cultivation 11
Curing.
 In field 17
 In sheds 18
Cummer crates 20
Cost of growing 21
Drainage—Necessity of 2
Drills 9
Fertilizers 3-7
 Amount of N., P and K., removed by crop 4
 How applied—Broadcast or in rows 7
 When applied 7
 Recommendations 7
Fitting land 3
Grading 16
Hand drills 9
Hand weeding 14
Harvesting 17
Maggot 21
Manure as fertilizer 3
Manure and maggots 3
Manure and weed seed 3
Marketing 19
Markets 19
Muck.
 Depth—composition—nitrogen in 1
Packages and packing 20
Producing centers 1
Profits 21
Seed 8
 Amount per acre 10
 Conditions affecting vitality 8-9
 Depth to sow 10
 Distance apart 9
 Sources 8
 Testing 9
Seeding 9
Seed drills 9
Shipping points 1
Storing.
 In pits 18
 In storage houses 18
Varieties grown 8
Weeding 11-14
Wheel hoes 9
Yields 21

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 16.

LaFayette, Ind., July, 1909.

AGRICULTURAL EXTENSION.

G. I. Christie.

The field occupied and the amount of work accomplished by the Purdue University Agricultural Experiment Station and School of Agriculture, is increasing rapidly each year. Increased funds and equipment have allowed the men in charge to attack the agricultural problems in an extensive and thorough way, thus enabling them to secure much interesting and valuable data. Results of and information concerning the various lines of work have been published in bulletins and circulars.

The number of each bulletin and circular printed and distributed in the state has been small compared with the total number of farmers and others directly interested in agriculture. The number has been limited because of a lack of funds and for the further reason that all people are not interested in all the subjects treated. It is therefore deemed advisable to have parties acquaint themselves with the work of the departments and apply for bulletins and circulars in which they are directly interested.

To supply the general information relative to the Experiment Station and School of Agriculture, this circular has been prepared. In it will be found a brief outline of the work of the various departments with the name and number of recent publications available for distribution.

Persons interested in further details of the work mentioned should address questions and apply for bulletins or circulars to Purdue University Agricultural Experiment Station, LaFayette, Indiana.

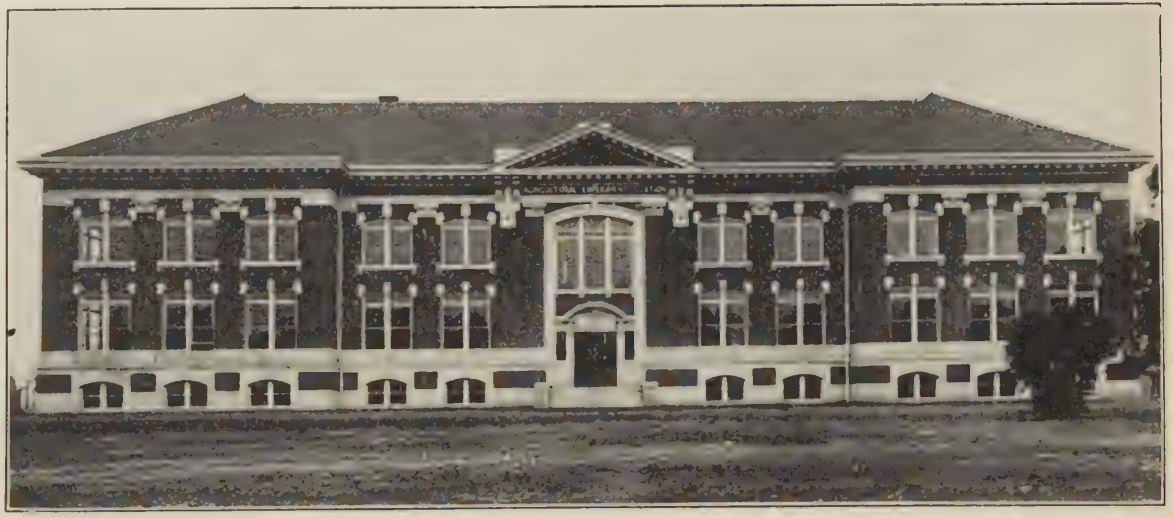


Fig. 1.

NEW EXPERIMENT STATION BUILDING.

Erected in 1908 at a cost of $100,000.00.

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION.

ARTHUR GOSS, Director.

The Agricultural Experiment Station was organized in 1887, under the act of Congress known as the Hatch Act. It employs a staff of scientists, skilled in agronomy, animal husbandry, dairying, horticulture, botany, chemistry and veterinary science. These workers are engaged in collecting scientific facts and truths applying to agriculture, preparing bulletins and answering correspondence. Further support was given to this work through the passage of the Adams Act by Congress in 1906.

Through the act of the Indiana State Legislature of 1905 the Station was enabled to take up new lines of investigational work and to establish a department of agricultural extension. Already much work has been accomplished through co-operative experiments in soils, field crops and horticulture, extensive cattle feeding experiments, herd tests, county experiment stations, special educational trains, fair exhibits, district short courses, newspaper articles and addresses made by the workers at the various state and county meetings of the agricultural organizations.

To advance the lines of work of the Experiment Station already under way and to meet the urgent demands for information on new problems, the State Legislature of 1909 increased the Station maintenance fund to $75,000 per annum. Of this amount, $15,000 is to be used for soil and crop improvement; $10,000 for dairying; $10,000 for animal husbandry; $5,000 for poultry; $10,000 for horticulture; $5,000 for hog cholera and other animal diseases; $10,000 for agricultural extension and $10,000 for general expenses.

In addition to the investigational and extension work, the Experiment Station administers through the office of the State Chemist, the Fertilizer Control Law passed in 1901 and the Stock Food Control Law passed in 1907 by the Indiana State Legislature.

In these ways the Station has become a source of definite information and helpfulness for the entire agricultural class of the state.

CHEMICAL DEPARTMENT.

ARTHUR GOSS. S. D. CONNER. J. B. ABBOTT.

A large part of the work of the Chemical Department is along the line of soil improvement. Much of this is done in cooperation with farmers in various parts of the state. Various problems are studied among which may be mentioned the following:

A study of the fertilizer requirements of various crops and different types of soil.

A comparison of various substances, including manure, which are used for fertilizing purposes, with a view of determining their value to the farmer.

The lasting effect of fertilizing substances.

A study of some of the acid soils of the state with a view of determining the form and quantity of lime to be used.

A study of the effect of fertilizers and chemicals in preventing insect injury.

Purely chemical work in the laboratory has also been carried on. It may be said in this connection, however, that the Station does not analyze miscellaneous soils to determine their fertilizer requirements. There is no chemical method known that will show reliably the availability of the various elements in the soil. Soil fertility is a variable factor which is influenced by the type of soil, kind of crop, the climatic and biological conditions and other factors. For this reason we cannot recommend soil analysis as a method for testing the plant producing powers of a soil. A field fertilizer test with various kinds of fertilizers carried on for several years, is the only sure method of determining the needs of a soil. As such a method is obviously impracticable for many farmers, the Station has endeavored to conduct such tests on the different types of soil in all parts of the state. Farmers wishing information concerning their fertilizer needs should write to the Experiment Station, giving a description of the type of soil, the kind of treatment it has had and the kind of crop intended to be grown, together with any other information bearing on the particular case. This Department will then be able to advise him intelligently.

Live stock farming is urged as being one of the most economical and profitable ways of building up the permanent fertility of the farm, provided, however, that proper care is taken of the manure. In fact, in many cases, the greatest source of profit in such farming is in the manure.

Using the figures of the State Statistician, on April 1, 1908, there was enough live stock in Indiana to produce over $55,000,000 worth of manure annually. It has been carefully estimated by Experiment Station authorities that over one-third of the farm-yard manure produced is wasted. This would mean an annual loss to the farmers of Indiana of about $18,000,000. This loss can be decreased in various ways. For instance haul all manure to the field as soon as possible; use cement floors in stable and manure pit; do not pile under eaves or in open yards; reinforce with chemical fertilizers like acid phosphate or kainit. It has been proven, that the reinforcement of manure will increase the crop producing power from one to two dollars a ton. On all the manure made in Indiana, this would mean an annual profit of practically $25,000,000.



Fig. 2. Fertilizer test on clay soil, Clinton county.

Although a system of live stock farming in general, is probably the most economical method of building up a farm, there are other methods that can be profitably followed. In fact in some special cases the use of commercial fertilizer is even more profitable, as for instance the use of potash salts on peat or muck soil. The fact should not be lost sight of that by combining the proper fertilizers with an intelligent legume rotation, badly worn soils can be built up to a high state of fertility, and at the same time yield good profits without any injurious effects upon the soil. Commercial

fertilizers, however, will not take the place of a good system of farming. They should be used only as a supplement.

The above illustration shows what the application of 100 pounds of fertilizer (in this case 1.6 per cent. nitrogen, 8 per cent. available phosphoric acid, and 2 per cent. potash) will sometimes do, the increase in yield being 30 bushels per acre. The large increase from so small an application of fertilizer in this case may be partly explained by the fact that vast numbers of root lice were on the unfertilized corn and scarcely any on that which was fertilized. As a rule fertilizer acts beneficially in such cases, by pushing the crop along rapidly at the start thus getting it out of the way of insects, the fertilizer which is most suited to the soil, being the one to use. The lice seem to prefer a small tender plant rather than a large, rapidly growing one.



Fig. 3. Experiment showing the lasting effect of fertilizer on clay soil, Scott county.

In the above experiment heavy applications of fertilizer were applied three years previously, none being applied afterwards. It can be plainly seen that phosphates and other fertilizing materials, nitrogen excepted, do not wash out of the soil quickly; neither do they have an injurious effect upon the soil in after years. The lasting effect of a fertilizer seems to be in direct proportion to the amount applied.

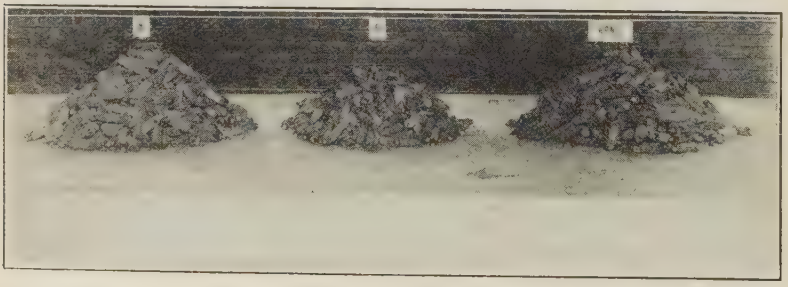


Fig. 4. Experiment showing lasting effect of potash on muck soil, Newton county.

Bus. per acre, 42. **Bus. per acre, 22.** **Bus. per acre, 39.**

In 1904 heavy applications of potash and other fertilizing materials were made on peat or muck soil in Newton county. Corn was grown continuously without any additional fertilizer being added. The crop was harvested and weighed each year. The above illustration shows the results on three of the plots the fourth season after the fertilizer was applied. The plot marked K had 207 pounds muriate of potash applied to the acre. Plot marked O had no fertilizer. Plot marked KPNCa had nitrogen, phosphorus, potash, and lime applied. The result shows that potash is the element needed on this soil, also that potash will not leach out of such soil, and that the application of fertilizer will not injure such soil at any time. During the four seasons, the one application of 207 pounds of muriate of potash produced a total increase over the unfertilized plots of 183 bushels per acre, and at the same time improved the quality of the corn fully 50 per cent.

Any one wishing more detailed information concerning the above experiments, should write to the Experiment Station for Circular No. 10.

AGRICULTURAL DEPARTMENT.

A. T. Wiancko. M. L. Fisher. C. O. Cromer.

The ultimate object of the work of this Department is to bring about improvements in field crop production by testing and introducing improved varieties and valuable new crops throughout the state, by improving the best existing varieties or strains through systematic breeding, by studying soil preparation and general cultural methods, systems of cropping and crop rotation, etc.

The following are some of the more important lines of work in progress:

1. Testing the value of new and promising varieties of all kinds of grain and forage crops of interest to Indiana agriculture.



Fig. 5.

DWARF ESSEX RAPE.
Yield, 17 tons per acre.

THOUSAND-HEADED KALE.
Yield, 10.7 tons per acre.

2. The improvement of the leading farm crops by systematic breeding and selection, including studies of methods. The corn breeding plots are located in different parts of the state with the object of producing, in each case, a type of corn particularly suited to that locality.

3. A study of the relative productiveness of several different types of seed ears selected from the same variety of corn.

4. A study of the practicability of developing in this latitude, a variety of corn producing two or more ears per stalk.

5. A study of the effects of detasseling upon the yield of corn.

6. A study of the effects of continued selection of seed from sucker bearing stalks upon sucker producing tendencies and productiveness of corn.

7. A study of the relative value of lots of seed corn selected at different stages of maturity.

8. A study of the longevity of various farm seeds when stored under ordinary farm conditions.

9. A study of the relative merits of various corn cultural implements, and various systems of corn cultivation.

10. Studies of the relative merits of various systems of crop rotation on three different soil types.



Fig. 6. A field of soy beans planted in rows 24 inches apart. The yield of grain was 21.8 bushels per acre, and the green weight of forage about 6 to 8 tons per acre.

11. Experiments to determine the adaptability of alfalfa to various conditions throughout the state, and the relative merits of summer and early fall sowing of alfalfa, with and without the application of lime. Such experiments are under way in nearly every county of the state.

12. Cooperative tests of leading varieties of corn, oats, wheat, cow peas, and soy beans. These tests include from three to five of the leading varieties of each crop, and are distributed as uniformly as possible throughout the state, from six to a dozen being located in each county. The total number of such tests going on this year is 947, distributed as follows: corn 641, wheat 106, oats 53, soy beans 81, cow peas 66.

The principal objects of these cooperative tests of varieties are:

a. To determine the relative merits of the better varieties and find out which should be recommended to farmers in any given locality.

b. To determine the varieties most suitable for foundation stock in the work of breeding for any given locality.

c. To bring the better varieties to the notice of farmers by giving them an opportunity to make comparitve tests on their own farms.

d. To find out new or promising varieties, and test them beside standard varieties of known value.

e. To encourage systematic crop experimentation among farmers.

Publications. Among the recent publications of results of work in the Agricultural Department are the following:

Bulletin No. 114. Winter Wheat.

This bulletin contains the results of tests of 68 varieties of wheat on the University farm in 1901 to 1906 inclusive, and includes descriptions of the varieties, discussions of their relative milling qualities, and analyses showing relative nitrogen content, and a general discussion of the best methods of wheat production.

Bulletins Nos. 117, 124 and 132. Results of Co-operative Tests of Varieties of Corn, Wheat, Oats, Soy Beans and Cow Peas.

These bulletins contain the results of tests of several leading varieties of these crops on several hundred farms throughout the state during 1906, 1907 and 1908.

Bulletin No. 120. Soy Beans, Cow Peas and Other Forage Crops.

This bulletin contains the results of several years' tests of varieties, descriptions of the varieties of soy beans and cow peas tested, the result of tests of various cultural methods, the value of various forage crops for growing in succession for soiling purposes, and a general discussion of the conditions necessary to the successful production of soy beans and cow peas, both of which seem destined to become important crops in Indiana agriculture.

Bulletin No. 110 (Revised edition). Corn Improvement.

This bulletin contains a discussion of seed corn selection, testing and preparation for planting, methods of corn breeding and special seed production, with full discussion of the corn score card and its use in corn improvement. It also contains numerous photographic illustrations to aid the farmer in selecting good seed corn.

Bulletin No. 122. Alfalfa in Indiana.

This bulletin contains the results of experiments on about 70 farms, in as many different parts of the state, to determine the adaptability of alfalfa to various soil conditions, various methods of seeding, and the best time of year to sow, with a general discussion of the value and use of alfalfa, and what is so far known concerning the conditions necessary to its successful production in Indiana.



Fig. 7. Planting the small grain breeding plots involving individual plant selection.

Press Bulletin No. 143. Results of Experiments in Summer Sowing of Alfalfa.

This contains a summary of the results of about 80 experiments in 52 different counties of the state, showing results of summer sowing of alfalfa in 1907, under a great variety of conditions.

Press Bulletin No. 145. Results of Variety Tests of Winter Wheat.

This contains the results of the winter wheat variety test for last year (1907-8), and the averages of the last three years.

Press Bulletin No. 147. Results of Tests of Varieties of Oats.

This contains the results of the oats variety test for last year and the averages of the last four years.

Press Bulletin No. 148. Supplementary Forage Crops.

This contains suggestions for farmers requiring some annual forage or pasture crop to take the place of clover.



Fig. 8. Thinning alfalfa in the alfalfa testing and breeding grounds.

ANIMAL HUSBANDRY DEPARTMENT.

J. H. Skinner. W. A. Cochel.

The Animal Husbandry Department has, for a number of years, devoted a large proportion of time and attention to investigating methods of feeding and management of beef cattle and swine more especially with a view to determining such questions as confront the farmer in actual practice and under prevailing conditions. The work of the Department may be considered under two distinct heads.

1. Investigational work.
2. Extension work.

INVESTIGATIONAL WORK.

For this purpose the Department has equipment such as lots, shelter, silo, racks, troughs and mangers to feed 140 steers and 200 head of hogs at a given time. Experiments involving the use of 110 cattle and 300 hogs have been conducted during the past year.

Beef Production. The experimental cattle feeding has been planned with a view to securing accurate information in regard to the influence of age on the economy and profit of beef production, the effect of silage as measured by the rate and cost of gain and on the finish of the cattle, the use of nitrogenous concentrates as shown by their effect upon the behavior of steers in the feed lot as well as the carcass, and the relative merits of long and short feeding periods. These problems have been under study for the past three years in order that variable factors might be eliminated as largely as possible. There have been more than 400 steers used in this work fed under conditions which can be duplicated on any farm in the state.

Publications available:—

Bulletin No. 115. Steer Feeding.

A report of results secured during the winter from feeding ear corn with (1) clover hay, (2) linseed meal, shredded stover and oat straw, (3) shredded stover and oat straw.

Bulletin No. 129. Steer Feeding, II. Winter Steer Feeding 1906-7 and 1907-8.

A report of the results of feeding experiments under the following topics. (1) The influence of age on the economy and profit in fattening steers in winter. (2) Corn silage as a roughage in fattening two year old steers. (3) Cotton seed meal as a supplement in fattening two year old steers. (4) Timothy vs. clover hay as a roughage in fattening two year old steers.

Bulletin No. 130. Steer Feeding, III. Results of Short vs. Long Feeding Periods.

This bulletin defines what is meant by "short feeding" and "long feeding," also presents the information secured

as to rate and cost of gain, feed consumed, degree of finish attained and profits secured from feeding through a "short" and "long" feeding period. There is also a complete record given of feeding the "Short-fed Special" champions shown by the Station at the 1907 International.

Circular No. 8. Purchasing Feeders.

A discussion of the advantages and disadvantages of purchasing feeders on different markets. Special attention is given in this circular to southern Indiana conditions where large numbers of cattle are annually produced.

Circular No. 12. Methods of Beef Production in Indiana.

This gives information which resulted from an investigation of the methods of beef production in Indiana in 1906. This circular covers a wide range of topics relating to beef production and is a report of information gathered from the replies to a list of 100 questions sent out to 2500 Indiana cattle feeders.

Circular No. 14. Factors which influence the Value and Cost of Feeders.



A "FEEDER'S TYPE."

Fig. 9. High grade Angus steer 13 months old. Fed corn, cotton seed meal and clover hay. Daily gain 3 lbs. for 6 months, weight 1095. A "Feeder's Type" suitable for the production of "Baby Beef."

A discussion of various types of feeders and conditions which influence the market price and value of feeding cattle. It was published with a view of giving information that would enable purchasers, especially in southern Indiana, to improve their cattle and to give cattle feeders information that should enable them to intelligently select a more desirable type of cattle for feeding purposes.

Pork Production. A detailed study of the value of feeds used as supplements to corn has been made during the past 10 years. Much valuable information in regard to skim milk, butter milk, tankage, linseed oil meal, soy bean meal, middlings and bran has been secured. A study of the cost of maintaining brood sows and young growing pigs through the winter on different rations is now in progress. Various questions such as the proportion of water to feed, amount of feed per hundred pounds live weight, the influence of Yorkshire blood on Poland China and Berkshire breeds, the rate and cost of gains with pure bred pigs from lard and bacon types are also being conducted.



AN UNPROFITABLE TYPE.

Fig. 10. Grade Angus steer, same in age and treatment as No. 1. Daily gain 1.97 lbs. for 6 months, weight 825 lbs. An unprofitable type from the standpoint of both producer and feeder.

Publications available:—

Bulletin No. 108. Soy Beans, Middlings and Tankage as Supplements in Pork Production.

Bulletin No. 126. Supplements to Corn for Fattening Hogs in Dry Lot.

These bulletins give the proportion of feeds used, the amount of grain required to produce 100 pounds of pork and the rate and cost of gains made by hogs under different methods of feeding and management.

Mutton Production. This work has been confined entirely to a study of the maintenance, rations involving dry and succulent feeds for breeding ewes in winter and to a comparative study of fall and spring lambs.

The Station has done no work either with dairy cows or horses up to the present time.

EXTENSION WORK.

In this important branch of the work, numerous addresses are given, visits to the feed lots made, meetings of feeders attended, co-operative experiments carried on and a very large correspondence conducted.

Numerous addresses are made by members of the Department before farmers' institutes, live stock breeders and feeders' meetings, farmers' clubs, district short courses and similar gatherings. These are based upon the work secured in the experimental feed lots and are amply illustrated with charts and bromides.



THE RESULT OF CORN, COTTONSEED MEAL AND CORN SILAGE.

Fig. 11. Two year old steers fed on corn, cotton seed meal and corn silage for 6 months. Daily gain 2.58 lbs. per head, weight 1428 lbs. These cattle sold for $7.25, topping the Chicago market for the week ending May 29, 1909.

Visits of inspection are made to various sections of the state in order to study practical conditions, obtain information as to problems before feeders and give advice when solicited as to methods of feeding and management of live stock.

Cattle Feeders' Meetings. A semi-annual meeting of the cattle feeders of the state is held at the Station in November and May. At these meetings the results secured from feeding are presented in tabular form and the effects of the feeds upon the cattle is shown by a visit to the feed lots.

Co-operative Work. In many sections of the state the Department is co-operating with progressive feeders who are in a position to keep records of feed consumed, and gains, by recommending rations, visiting the feed lots and giving advice as to feeding when requested.

Correspondence. One of the most important lines of work in the Animal Husbandry Department consists in answering inquiries as to the selection and purchase of feeders, the use of various feeds such as corn silage, cotton seed meal, linseed meal, tankage, gluten feed, alfalfa feeds, etc. Many inquiries are received by the Department concerning the results of the feeding experiments with cattle, sheep and hogs. This is one of the most valuable lines of work carried on and many farmers should make use of this means of securing information from a reliable source, which is freely given.



THE RESULT OF CONTINUED USE OF PURE BRED SIRES.

Fig. 12. Note uniformity in blocky beef type, quality and early maturity. These yearlings were all sired by one bull from grade cows. They were raised in Lawrence county on land that is suitable only for grazing. They were fed by the Station on corn, cottonseed meal and clover. Daily gain 2.19 lbs. for 7 months, weight 1156 lbs. Sold June 23, 1909, for $7.35, topping the Chicago market by 10 cts. per cwt. The highest price paid from March to July.

VETERINARY DEPARTMENT.

R. A. Craig. H. H. Madaus.

The most important line of investigation work engaging the attention of this Department is a study of problems relating to the control of hog cholera.

It is believed that until a cheap and safe vaccine for the prevention of this disease is secured, that this method of prevention so commonly used in the control of some animal diseases, will not come into general use. A better knowledge of the hog cholera virus is necessary before a satisfactory vaccine can be produced, or present methods of prevention improved. The virus of this disease is being studied in the laboratory and different methods of vaccination are used on the experimental hogs.

During the past six months the Dorset-Niles hog cholera serum has been used on 254 sick and exposed hogs. In the different herds treated, 193 hogs were left untreated and used as checks. Of the treated hogs 79.14 per cent. lived and of the checks 47.67 per cent. lived. Judging from the experience with some of the herds a larger per cent. of the animals treated with serum would have lived, if dieting and good care had been used as a part of the treatment.

The Dorset-Niles serum will be produced in a small way this year.

DAIRY HUSBANDRY DEPARTMENT.

O. F. Hunziker.

H. C. Mills.
P. H. Crane.

George Spitzer.
W. F. Epple.

Purpose of the Department. To furnish information to milk producers on the economic production of sanitary milk. To assist the manufacturer of butter, cheese, ice cream and condensed milk in successfully turning out a high quality of dairy product.

Plan of Work. The work of the Department is divided into

a. Field work.
b. Experimental work.

Field Work.

Special Dairy Meetings and Institutes are conducted in all sections of the state throughout the year. Instruction is given to the dairy farmer on the selection and breeding of dairy cows; grading up, feeding, care and management of the dairy herd; care and handling of milk and cream; care and operation of the farm separator and the Babcock test; farm buttermaking; organization of co-operative creameries; and establishment of markets for dairy products.

Send for Circular No. 11 on "The Improvement of the Dairy Herd," Circular No. 13 on "Feeding of Dairy Cattle," and Press Bulletin No. 142 on "Better Markets for Indiana Butter."



Fig. 13. A wasteful way of feeding corn to dairy cows.

Visits to Dairy Farms and Creameries. These visits make it possible for the dairyman and factoryman to receive personal advice and assistance in the solution of their local problems. In communities contemplating the establishment of co-operative creameries the advisability of the installment of such creameries is carefully investigated and specifications for suitable buildings and equipment are furnished by the Department.

Butter-makers receive assistance in the operation of their plants, in making the proper over-run, and in the manufacture of a high quality of butter which conforms in composition with the laws of the United States Internal Revenue Department.

Educational Butter Scoring Contests are held bi-monthly for the purpose of educating farm and factory butter-makers in the demands of the market. Empty packages are sent free of charge to all contestants. The butter is scored by a Government Butter Expert and the scores and criticisms are forwarded at the conclusion of each contest to the respective butter-makers. These contests are a splendid opportunity for the progressive butter-maker to perfect himself in his business without expense. Every butter-maker in the state should take advantage of these contests.



Fig. 14. Corn silage, properly put up, is the most economical succulent winter feed for dairy cows.

DAIRY INVESTIGATIONS.

Co-operative Herd Test Experiments are conducted with all Indiana dairymen desiring to know the annual production of milk and butterfat of their cows. Sample bottles, dippers, etc., are furnished free of charge for this work. Over 300 annual records of Indiana dairy cows have been made by the Department. The only possible way of making a herd profitable is to know the individual production of each cow. This can be done by weighing and testing the milk regularly, and then weeding out the poor cows and breeding the profitable ones to pure blood sires. Send for Bulletin No. 127.

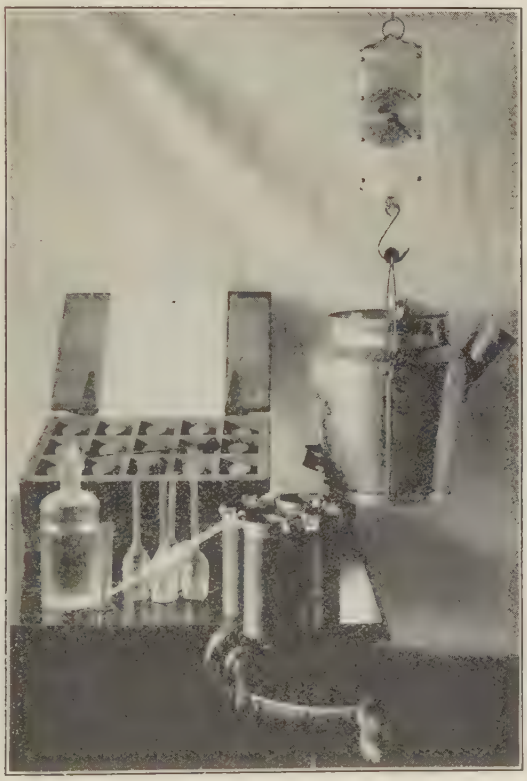


Fig. 15. The milk scales and the Babcock tester are the corner stones of profitable milk production. No dairyman can afford to do without them.

Official Cow Tests are made by representatives of the Department for any Indiana breeder of dairy stock, who desires to have his animals try for entry in the Advanced Registry or in the Register of Merit.

Experiments to Control the Moisture Content of Butter have been in operation for two years and a bulletin stating the results of these investigations will be issued this year. Information that will enable the butter-maker to control the per cent. of moisture in his butter will be of inestimable value to the dairy interests of the state.

Cream Testing Experiments have been conducted to determine the accuracy of single and composite samples of cream, and to find out the best method of testing. It was conclusively demonstrated that, if composite samples are taken, they must be kept in tightly sealed bottles and in a cold room. Otherwise there is evaporation of the water and, consequently, an increase in the per cent. of fat, causing the latter to be too high. A creamery receiving 20,000 pounds of fat per month may easily overpay its patrons to the ex-

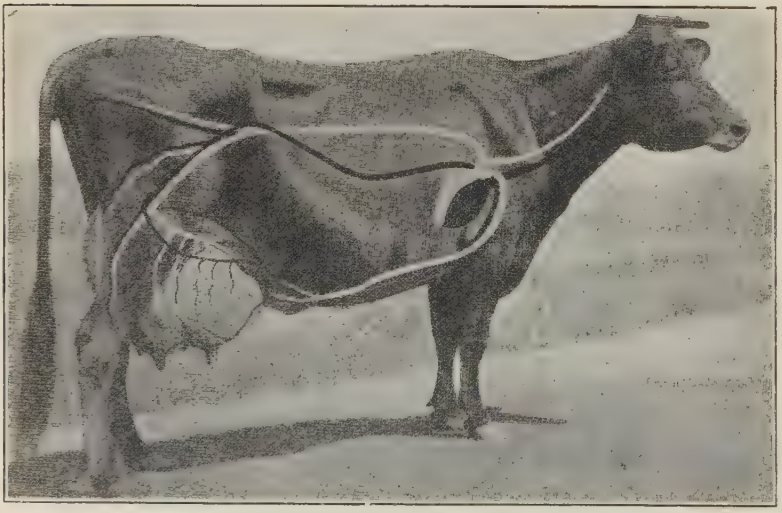


Fig. 16. A plentiful supply of blood to the udder is essential for large milk production. A large muzzle and barrel and a deep chest insure capacity for turning feed into blood.

tent of $500 per month where the composite samples are not properly kept. The safest way to test cream is to test the individual samples on the day they are taken.

A bulletin on this work will be issued this year.

The Pasteurization of Gathered Cream has been carefully studied with the view of determining its effect on the quality of the butter. This is of direct importance to the butter-maker and to the dairyman. One of the secrets of success lies in holding butter from the time when the supply is plentiful, the demand small and the prices low, to the time when the supply is short, the demand great and the prices high.

Condensed Milk Experiments were conducted to investigate the justice of the present law regarding the composition of the product and to determine the accuracy of the methods used in the determination of fat. The condensed milk industry is a valuable branch of the dairy industry. It affords a regular market for the milk producer and offers high prices for his product. The results of the experiments conducted by this Department show, conclusively, that the legal requirements for composition are far too high to enable the manufacturer to comply with the law. They further demonstrate that the methods used for fat analysis are incorrect and give too low and, therefore, misleading results. As the result of these findings the enforcement of the law on unsweetened condensed milk has been suspended for the time being. Send for Bulletin No. 134.

HORTICULTURAL DEPARTMENT.

JAMES TROOP. C. G. WOODBURY. B. R. RYALL.

The work of the Horticultural Department for the past year has progressed along the lines mentioned in the last issue of this publication. Investigations have been continued in regard to tomato growing, especially in relation to field methods of producing the crop for the canning factory; concerning onion growing, melons, orcharding, nut culture, small fruits, and the growing of catalpa and locust for post and pole production.

The investigation in regard to onion growing was carried out principally on the muck soils of the northern part of the state. A summary of the work is given in Circular No. 15, "Growing Onions from Seed." Practically all the important points in connection with the production of the crop are fully discussed and the operations described. The questions of preparation of the ground, selection of seed, cultivating and hand weeding are taken up; the present methods of the application of commercial fertilizers and barnyard manure are discussed, and improvements in present practices are suggested by which a more economical and effective use may be made of the plant food in fertilizers. The various processes connected with the harvesting, cleaning, storing and marketing are touched upon, with a short discussion of costs of growing, yields and profits.

The last season's work in the improvement of the Indiana cantaloup business is reported in Bulletin No. 135, "Growing Better Gems." The work in the field was carried on along two lines; spraying for the control of the rust, and seed selection to improve and make more uniform the type of cantaloup grown. Although the field selected for the spraying work did not happen to be so severely affected by the rust as many fields in the vicinity, yet the spraying increased the net profit by $11.49 per acre, with cantaloups selling at 32 cents a third bushel basket after charging all expense for material used and time consumed in making and applying it. Bordeaux mixture was the spray used, made according to the 5-5-50 formula, using five pounds copper sulphate and five pounds lime to 50 gallons of water. For full directions for making Bordeaux,



Fig. 17. These two lots of onions are exactly the same age and grew within 30 feet of each other in same field. At left, fertilizer had been applied between the rows; at right, under the row. (From Circular No. 15).



Fig. 18. The first hand weeding. Active boys make the best help for this work. Keep the weeders ahead of the weeds. (From Circular No. 15).

see Bulletin No. 118. The total cost per acre for the spraying was $2.11 and the gross profit $13.60. The method and time of application is fully described in the bulletin.

In connection with the improvement of the type of gem grown, a standard of perfection is indicated and methods suggested for selection and saving of seed. At the present time there is a great lack of uniformity in the product from the same locality, and very few growers are saving seed intelligently.

Bulletin No. 128, "The Small Fruits" issued September, 1908, gives cultural directions concerning the growing of the various small fruits; kinds of soils best adapted to the various sorts of fruit, distance apart to set, etc. Lists of the most desirable varieties for general planting are given for strawberries, raspberries, blackberries, gooseberries, currants, etc.

Much interest has been manifested in the question of catalpa and locust growing. Plantations of these trees have been visited in about 70 localities in the state, and careful records made of the growth of the two kinds of trees under different conditions of cultivation, soil, drainage, and climate. The data at hand at present covers about 250,000 trees. The work will be continued during the season, and it is expected to make the results available in circular form within a few months.

There is considerable demand from fruit growers in various parts of the state for assistance in working out individual problems. The Department has been meeting that need so far as possible by personal visits to orchards and is planning to enlarge the scope of this branch of the work during the coming season. The orchard fruits can be grown profitably in nearly all parts of the state if the right kind of care and attention is given the orchard. Owners in doubt about the needs of their trees, or who desire information in regard to spraying, pruning, etc., are urged to communicate with the Department of Horticulture, with the assurance that their needs will receive prompt attention.

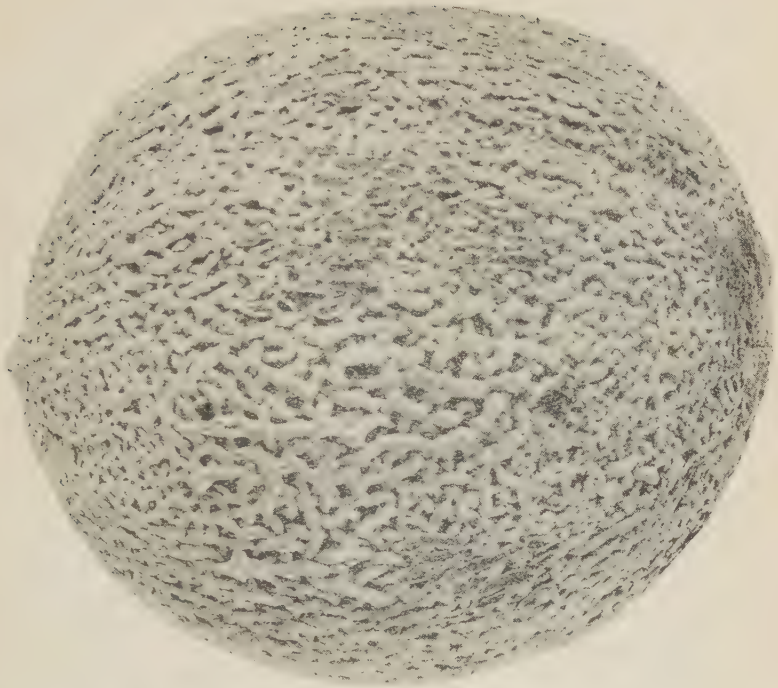


Fig. 19. Ideal type of Netted Gem, for outside appearance. This kind of a melon is usually of the highest quality and will ship well. (From Bulletin No. 135).

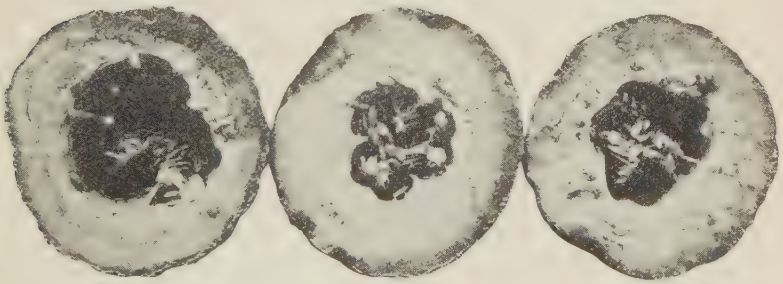


Fig. 20. Showing the variation in thickness of flesh. Seed should be saved only from thick-fleshed individuals. (From Bulletin No. 135).

STATE CHEMIST'S DEPARTMENT.

W. J. Jones, Jr.
O. C. Haworth.
E. G. Proulx.
C. Cutler.
A. C. Summers.
C. W. Rice.

The work of this Department consists in the administering of the Fertilizer and Feeding Stuff Control Laws and its importance will be more readily understood when it is considered that in 1908 the sale of fertilizer in Indiana reached a total of 102,309 tons with an estimated value of $2,457,406 while the sale of commercial feeding stuffs was probably largely in excess of this amount.

FERTILIZER CONTROL LAW.

The first fertilizer law in Indiana was passed in 1881 but as it provided only for the analysis of manufacturers' samples it was wisely amended by the legislatures of 1899 and 1901 to permit of the analysis of samples taken from consignments actually offered for sale in the state, thereby affording the protection to consumers which was desired.

Since the amended law became effective, this Department has collected from all parts of the state 7417 samples with the result that while of 481 samples secured in 1899 and 1900, 322 or 67 per cent. were so much different from the gurantee as to seriously deceive the purchaser, of 901 samples taken in 1908 only 47 or 5.2 per cent. failed to be within 10 per cent. of the guaranteed value and only 134 or 14 per cent. showed a deficiency in any ingredient of 20 per cent.

FEEDING STUFF CONTROL LAW.

This law was passed by the legislature of 1907 in response to the repeated resolutions of farmers' organizations and at the direct request of the Farmers' Legislative Committee which demanded it because of the well known fact that the concentrates sold in this state were adulterated with ground corn cobs, oat hulls, screenings, scourings, mill sweepings, flaxseed screenings, etc.

To illustrate the necessity for such a law, the analysis of a sample of linseed meal secured in the first inspection at LaFayette, is compared with the analysis of pure linseed meal in the following table:

Composition	Pure Linseed Meal	Alleged Linseed Meal
Moisture	7.1 per cent.	7.3 per cent.
Crude fat	9.5 per cent.	8.7 per cent.
Crude protein	33.0 per cent.	12.1 per cent.
Retail price per ton	$36.00	$40.00
Value per ton based on price of pure product		$17.62

The sample was not linseed meal but ground flaxseed screenings.

A sample of Vim Feed sold at various points in the state at from $14.00 to $25.00 per ton was found to consist of oat hulls having little or no feeding value and containing 1.8 per cent. crude fat and 4.3 per cent. crude protein.

The sale of cottonseed feed meal, a mixture of cottonseed meal and cottonseed hulls, for pure cottonseed meal was common and feeds which could not be sold in states having feeding stuff laws were shipped into Indiana.

In three cases since the passage of the law the substitution of cottonseed feed meal for cottonseed meal has been detected. In every case the feed was accepted without State Chemist's tags. In one of these cases the dealer rebated in accordance with the State Chemist's analysis and furnished tags. A second case is now in the courts and the third case resulted as follows:

F. A. Nave, Attica, Ind., received from the J. Lindsay Wells Co., Memphis, Tenn., 30 tons of alleged Cottonseed Meal, Star Brand No. 44, supposed to contain 41 to 45 per cent. crude protein. The feed was shipped in plain, unmarked bags *without State Chemist's tags* and a sight draft for $822 attached to bill of lading. On request an inspector was sent to secure a sample and at once discovered that the material was cottonseed feed meal. At the same time he secured a sample of cottonseed meal, bearing State Chemist's tags, purchased by Mr. Nave from another company.

On analysis these samples gave the following results:

	Tagged Sample	J. Lindsay Wells Co. Sample
Moisture	7.0 per cent.	7.6 per cent.
Crude fat	9.4 per cent.	5.5 per cent.
Crude protein	41.1 per cent.	21.9 per cent.
Crude fiber	8.6 per cent.	22.9 per cent.
Crude ash	7.2 per cent.	4.3 per cent.
Nitrogen free extract	26.7 per cent.	37.8 per cent.
Price per ton at Attica	$27.30	$27.40

Under the rules of the Memphis Exchange the shipment was not good delivery but if accepted the purchaser was entitled to a rebate of $12.08 per ton or a total of $362.40.

The company selling the feed being outside the jurisdiction of the Indiana courts this Department secured the cooperation of Federal Inspector Jenkins who took a sample which was forwarded to the U. S. Department of Agriculture, where the results secured by this Department were confirmed and Inspector Jenkins instructed to confiscate the shipment as being sold in violation of the Federal Pure Food and Drug Law governing interstate traffic and such seizure was made by the U. S. Marshal on April 23.

In settlement the J. Lindsay Wells Co., repaid Mr. Nave the amount of sight draft less price of a small amount of the feed, used by him, paid the costs of a suit started in the Circuit Court of Fountain county and the cost of transporting the feed from Attica to the Nave farm. In addition the company plead guilty to violating the Pure Food Law, paid a nominal fine, gave bond to the U. S. Government guaranteeing future compliance with the law and shipped the feed to Illinois as Cotton Seed Feed Meal.



Fig. 21. Exhibit of fertilizers and feeding stuffs.

The cases mentioned are typical of what has been accomplished by the law with all classes of feed previously sold in this state without regard to name or composition. For example, wheat and corn bran, wheat bran and screenings are now sold for what they are instead of wheat bran as was the case before the law was enacted.

Administration.

The laws are administered by the State Chemist and his deputies and as the only funds available for carrying on the work are those received from the sale of tags the Department is not in position to analyze samples of miscellaneous materials nor those taken by anyone except an authorized inspector.

Consumers of fertilizers and feeding stuffs are cautioned not to accept any package of either which does not have attached the State Chemist's tag bearing the minimum guarantee and other facts required by law and countersigned with his official signature.

In purchasing feeds examine not only the guarantee of crude fat and crude protein but also the list of ingredients used in their manufacture.

If inspections are desired notify the State Chemist of the amount to be inspected and the official number of the fertilizer or feed and if the shipment justifies an inspection an inspector will be sent to secure a sample without cost to the consumer.

Interested persons should apply for Bulletin No. 131.

AGRICULTURAL EXTENSION DEPARTMENT.

G. I. Christie. G. M. Frier.

The work of the Agricultural Extension Department consists of devising and executing schemes which will interest the people of the state in improved methods of agriculture and at the same time give to them information in a direct and usable form. Of the many agencies employed, a few of the more important will be discussed.

District Short Course. The district short course is designed to meet the needs of people who are unable to attend the Farmers' Short Course at Purdue. It carries out to and reaches thousands of people with a fund of information in a most direct and effective way. These courses are held in districts remote from the University and in towns supplied with good railway facilities and buildings adapted to the work. They last for one full week and the instruction consists of practical judging of corn and live stock with demonstrations and lectures on all other important phases of agriculture and domestic science. The expenses of the course are met by charging a membership fee. That this form of instruction is popular is shown by the attendance at the courses held:—Rushville, 125; Centerville, 511; Worthington, 477.



Fig. 22. District Short Course at Centerville.

Educational trains. The special train has become an important factor in the dissemination of agricultural information. While the information given through the educational train has been very similar to that given by farmers' institutes and bulletins, yet when these same facts are backed by a large railroad corporation and given the momentum of a railway train rushing over the state, they take new form and impress people more forcibly. As a result of the train work, many people have been moved to action and they are doing those things which they have long felt and known should be done but heretofore have not done. The following table gives a record of the special trains run in Indiana.



Fig. 23. Farmers meeting a Special Educational Train.

Record of Special Train Work.

RAILROAD	SUBJECT	Date of Train	Days Occupied	Stops Made	Miles Run	Attendance	Bulletins distributed
L. E. & W.	Corn	Dec. 26 to 29, 1905	4	45	425	8000	8000
Monon	Corn	Mar. 26 to 29, 1906	4	42	267	8700	10,000
L. E. & W.	Corn	Nov. 13 to 17, 1906	5	49	455	5000	5000
C. H. & D.	Corn	Feb. 18 to 19, 1907	2	23	160	5000	6000
Penn. Lines	Corn	Feb. 25 to Mar. 13, 1907	15	145	2000	35,000	46,000
Wabash	Dairy	Mar. 19, 1907	1	9	96	1600	1600
B. O. & S. W.	Horticulture and Soils	Nov. 19 to 21, 1907	3	24	223	4000	8000
Monon	Dairy	Dec. 9 to 13, 1907	5	39	410	4000	4500
C. H. & D.	Soils	Mar. 9 to 10, 1908	2	18	160	3000	3500
C. & E. I.	Corn	Mar. 11 to 13, 1908	3	27	180	4400	4500
Erie	Corn	Mar. 2 to 4, 1909	3	29	153	3470	3500
E. & T. H.	Corn	Mar. 8 to 10, 1909	3	33	242	5798	5800
E. & I.	Soils	Mar. 11 to 12, 1909	2	22	109	2515	2550
Total			52	505	4780	90,513	108,950

Fair Exhibits. During the past year exhibits have been made at the Tippecanoe County Fair, Indiana State Fair and the National Corn Exposition. Through these exhibits an attempt is made to place before the people the results of the various lines of station work. This is accomplished by means of grains, fruits, soils, feed stuffs, fertilizers, large charts, practical demonstrations, etc.

Experts from the several departments attend the exhibits and assist visitors in gaining from the display and demonstrations the information desired. In this way the exhibits have proved helpful and beneficial. In the near future it is planned to make exhibits at several of the county fairs of the state.



Fig. 24. A Farmers' Excursion at Purdue.

Excursions. As a means of acquainting the people of the state with the conditions and work of Purdue, the county excursion is effective. Through Farmers' Institutes and other county organizations the trip is planned and a special train secured.

Upon arrival at the University the parties are conducted through the buildings and over the experimental grounds where the growing crops, fruit and garden truck can be studied. They are also given an opportunity to visit the barns and inspect the live stock. Features of special interest to the women are the working dairy and the domestic science laboratories.

The following counties have recently made excursions to Purdue: Clinton, Hamilton, Hendricks, LaPorte, Huntington, Randolph, Hancock, Lake, Jasper and Howard.



Fig. 25. Spraying Demonstration.

Young people's contests. This Department has co-operated in the organization of young people's clubs and contests. These organizations require the members to conduct some definite piece of work such as growing a plot of corn, baking bread, making a garment, etc., and to exhibit the product for which premiums are offered. The premiums offered are of all types and values, but are fast taking on a more educational character. The higher premiums consist of a trip, with all expenses paid, to the Farmers' Short Course at Purdue University. Ninety-one boys and girls from the clubs of the state took the week's course in January, 1909.

Correspondence. Answering correspondence and sending out circulars of information, form an important part of the extension work. With the increasing interest among the people of the state in experiment station work has come an increased demand for information on local problems. These queries and requests in the main must be answered by letters. During the past year this Department has sent out more than 24,000 letters to the farmers of the state.

SCHOOL OF AGRICULTURE.

JOHN H. SKINNER, Dean.

PURPOSE.

The purpose of this school is to inspire a love for country life and give young men and women a broad, well rounded education; to educate them for the business of farming and other important positions requiring agricultural training. This is accomplished through a study of the many subjects covering the various phases of the great field of Agriculture, and the fundamental sciences, Biology, Chemistry, Physics, Mathematics, English and History. A large number of courses are prepared to meet the needs of farmers' sons and daughters. Those with limited means and preparation have been provided for as well as others.

INSTRUCTION.

The instruction in Agriculture is practical and thorough, consisting of recitations, lectures and laboratory work in which agricultural science and practice are systematically taught. The student deals with the common every day problems of the farm, works with soil, plants, live stock, fertilizers, and dairy products, and is constantly working with the things with which he comes in contact on the farm. Agricultural students analyze soils, study crop rotations and production, judge grains, handle and judge live stock, study selection, feeding, breeding, production and care of live stock, practice grafting, budding, and pruning, judge fruits and vegetables, study the life history, characteristics and habits of insects and fungi, and method of preventing their ravages, make up mixtures for spraying, test grains and other seeds, adjust and operate farm machinery, separate and test milk, make butter and cheese, and study the production and care of dairy products, and thus secure practical knowledge of these various farm products and operations.

The School of Agriculture consists of five distinct departments, viz., Agricultural Extension, Agronomy, Animal Husbandry, Dairying, and Horticulture, to which a large corps of instructors devote their time.

DESCRIPTION OF DEPARTMENTS.

Agricultural Extension.

Professor G. I. Christie in Charge.

The work of this department comprises all those forms of agricultural instruction that aim to reach people on the farm and in the public schools. The Department attempts to place before these people the teachings of the School of Agriculture and Experiment Station. It also attempts to interest the young people of the farm and schools in agricultural studies and to impress upon them the importance and value of an agricultural education.

This work is accomplished through district short courses (which consist of practical instruction in agricultural subjects occupying a full week and given at a central place in the various congressional districts of the state), industrial clubs and contests, special educational trains, exhibits at county and state fairs, county farm tests, special literature, excursions from the various counties of the state to the University, and lectures before teachers' institutes, Chautauquas, farmers' institutes and other organizations.

Agronomy.

Professor Wiancko in Charge.

Professor Latta, Assistant Professors Fishier, Nye (Agricultural Engineering), Instructor Conner (Agricultural Chemistry).



Fig. 26. Students judging corn.

The Department of Agronomy gives instruction in farm crops, their characteristics, culture and uses, cropping systems, seed testing, and crop improvement; the physical characteristics of soils, methods of tillage; soil fertility, manures and fertilizers; the chemistry of soils and crops; the principles of land drainage and drain construction, farm machinery, cement construction and farm buildings; farm economics and practical problems in management; the relation of theory, experimentation, science and practice in the advancement of agriculture.

Animal Husbandry.

Professor Skinner in Charge.

Professor Craig (Veterinary Science), Assistant Professor Smith, Instructors Arnett, Crane (Poultry), Hamer.

The instruction in this Department is intended to give students a knowledge of the importance, and value of the live stock industry, the various classes and breeds of live stock, and to inspire a love for live stock farming. Instruction is given in the history and characteristics of breeds, the principles of breeding, animal nutrition and feeding, care and management, veterinary anatomy and physiology, veterinary medicine and surgery, and the production and marketing of horses, cattle, sheep, swine and poultry. Much time is given to practice in scoring and judging and selecting the various classes and types of animals for breeding and feeding purposes and to the tabulation and study of pedigrees, method of registering, blood lines and family characteristics.



Fig. 27. Students studying the wheat plant.



Fig. 28. Judging Fat Cattle. Class of 1912 in Animal Husbandry.



Fig. 29. Judging Horses. Winter Course Class in Animal Husbandry.

Dairying.

Professor Hunziker in Charge.
Instructor Jarvis.

Instruction is given in the selection and management of the dairy herd; the secretion, composition and properties of milk; farm and creamery butter making; creamery management and machinery; testing milk and its products; city milk supply, and milk and dairy inspection; cheese making; the manufacture of condensed milk, ice cream and miscellaneous products.

Horticulture.

Professor Troop in Charge.
Assistant Boyle.

The instruction in this Department covers orchard management, fruit culture, vegetable gardening, and landscape gardening; fruit propagation, greenhouse and nursery management. The purpose is to acquaint students with fruit raising, vegetable gardening for both home and market purposes and successful methods of combating insects and fungi.

UNIVERSITY CALENDAR.

The Four Year Course will begin September 8, 1909.
The Farmers' Short Course will be held January 10-15, 1910.
The Winter School of Agriculture will open January 17, 1910.



Fig. 30. Students testing milk.



Fig. 31. Laboratory in creamery and dairy butter making.



Fig. 32. The first spraying for "Peach Leaf-Curl."



Fig. 33. Students judging apples.

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 17.

LaFayette, Ind., September, 1909.

THE FARMERS' ORCHARD.

J. Troop. C. G. Woodbury.

It is the purpose of this circular to discuss the home orchard from the standpoint of the general farmer; to take up in an elementary way the problems involved in caring for orchard fruits, especially the apple, with reference to selection of varieties, choice of a site for the orchard, the selection, planting, pruning and cultivation of the trees, and the protecting of the tree and fruit from the attacks of its most common enemies.

I.—FRUIT GROWING AND THE GENERAL FARMER.

It is the conviction of those who are most familiar with Indiana conditions, and is a fact borne out by the experience of commercial growers, that most localities in Indiana can be made to produce apples of high quality and attractive appearance if the proper care and attention be given the trees. Although there are great opportunities in the state for the commercial orchardist, there is and probably always will be a large proportion of Indiana farmers who are not interested in fruit growing as a commerical, money making

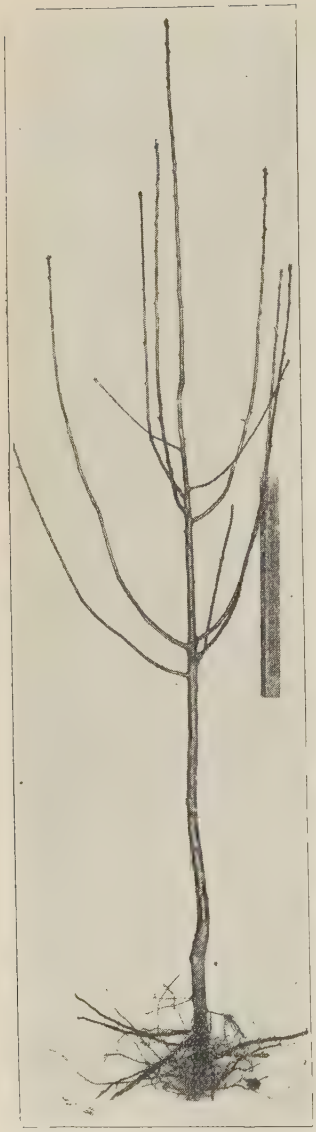


Photo by J. G. Boyle.

Fig. 1. A nursery tree with a well-developed and well-shaped head. Notice how the scaffold limbs are distributed.

proposition. Many of these farmers, although primarily grain-growers, or stockmen or dairymen, wish to maintain a small home orchard as an adjunct to their main lines of work for the purpose of having a home supply of good fruit. There is a proper place for such home orcharding as well as for the more strictly commercial aspects of horticulture, and the encouragement and development of the home orchard is one of the most important problems to be solved in connection with the development of the horticultural resources of the state.

That there are numberless non-professional fruit growers interested in having a home supply of apples, is proved by a day's journey of observation in any well settled portion of the state. The old apple orchard is an ever recurring feature of the landscape. It is significant of a wrong condition of affairs, however, that so many of the home orchards are *old* and that of the number that are young, so few present the thrifty vigorous appearance which would indicate that they are receiving some care and attention.

This condition may be attributed chiefly no doubt, to a lack of understanding on the part of the general farmer of the principles of fruit growing. Many general farmers hesitate to set out young orchards because they see such discouraging returns from the old ones in their neighborhood. The declaration is not uncommon, that for the general farmer it is cheaper to buy fruit than to raise it. As a matter of fact the families of such individuals might often testify that the fruit was neither

bought nor grown. There can be no doubt that it is cheaper to go without fruit than to have plenty of it. A small home orchard should yield an important part of the diet of every country family in the state. Such a general supply of home grown fruit would not affect the market for the commercial man, for the professional fruit grower still has the city consumer to supply, and in the number of good city markets within easy shipping distance, probably no state in the Union is more favorably situated than Indiana. The country population is not a fruit buying population except through necessity. It ought to, and may produce plenty of fruit for home consumption.

Instead of a well cared for, producing orchard as an indispensable part of the equipment of every farm, what do we see? We see a large proportion of the orchards failing to justify their existence. Numberless conversations which the writer has had at institutes, fairs and various kinds of farmers' meetings, reveal the fact that this condition is generally deplored, and that the majority of the neglected home orchards are in their present unsightly and unprofitable condition, not from a lack of good intentions on the part of the owner, but on account of a lack of definite knowledge as to how present conditions can be easily and cheaply remedied.

What is the trouble with the home orchard and with the general farmer as a fruit grower? The trouble with the orchard is neglect; the trouble with the general farmer as a fruit grower is his ignorance of the business and his idea that the growing

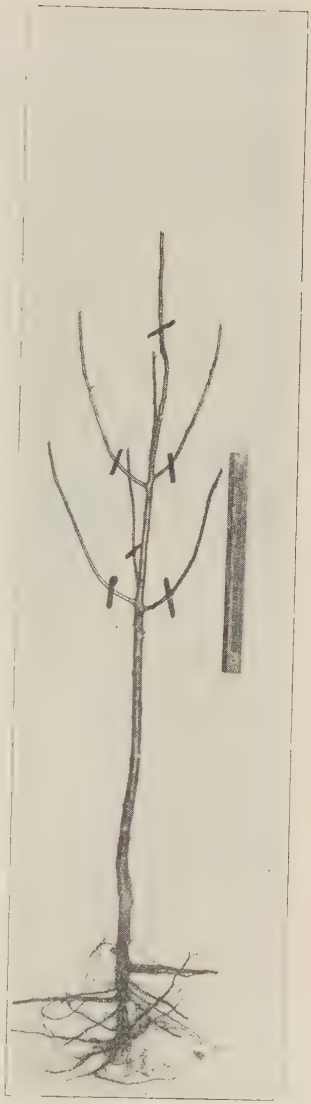


Photo by J. G. Boyle.

Fig. 2. Same tree shown in Fig. 1. The cross marks indicate where the limbs should be cut off when the tree is set.

of good fruit is something which is too difficult and expensive for him to undertake.

It is hoped that the suggestions and illustrations which follow, may do something toward overcoming this idea. It is hoped that at least some of the owners of neglected orchards may take measures which will put their orchards on a producing basis, and that some



Photo by J. G. Boyle.

Fig. 3. A good root-system for a nursery tree; unpruned.

who at present possess no home fruit supply may join the ranks of the amateur fruit growers and put out a home orchard.

II.—SETTING OUT AND CARING FOR THE HOME ORCHARD.

Where to set the trees.—The first question that comes to the mind of the amateur who is contemplating the planting of fruit trees, is the selection of the site. This is a problem that is confronted but once, but future success depends in great measure upon

its wise solution. It is not necessary that the location be ideal to justify the setting of a home orchard, but where there is a fairly wide latitude for choice, it certainly pays to give considerable attention to this matter. On many farms in the central part of the state, there is very little to choose in the matter of orchard location, because all conditions are practically uniform over the whole farm.

Drainage and elevation are two of the most important consider-



Photo by J. G. Boyle.

Fig. 4. Same root-system shortened in for setting. More severe pruning would not be injurious.

ations. Apples do *not* do well on poorly drained soil where water is liable to stand on the surface or about the roots of the trees. Good drainage is essential. For this reason the higher parts of the farm are usually better for orchards. On hilly land it is not necessary that the trees be on the very tops of the hills, but they should not be set in the pockets. On land which is nearly flat or gently rolling, the highest land is best adapted for orchard fruits. This is partly due to another factor than soil drainage. Low flat lands can be drained so that surplus water is quickly conveyed away from the

surface, but such lands may be unfit for orchard fruits, notwithstanding.

Air drainage is as important a consideration in fruit growing as soil drainage. On the still nights of spring, the cold air settles away from the slopes. It flows down hill and collects in the low flat pockets. Doubtless everyone has noticed this phenomenon while driving on still evenings. Often when the air above is relatively warm and dry, one passes into a depression and feels the chill damp air strike in at once. The difference in temperature between the low areas and the knolls is often great enough at some time during the spring, at the season of expanding buds and opening blossoms to mean the difference between a killing frost and uninjured flower buds.



Photo by J. G. Boyle.

Fig. 5. A poor type of nursery tree. The trunk is crooked and the head poorly formed.

A body of water exerts a modifying influence on the surrounding air temperature. A small stream or ravine even may furnish excellent air drainage and so make the surrounding area better fitted for fruit growing than it otherwise would be. A large body of water with good soil conditions often makes a locality famous, as the narrow strip along the east shore of Lake Michigan, comprising the Michigan peach belt.

Soil for the home orchard.—Fruit trees, like most other plants, appreciate good soil, although it is true that many paying orchards are on land that is unfit for general farming. Land may be too rocky or too hilly to be tillable, and still grow excellent fruit. The cheapness of such lands is generally an attractive feature to the commercial orchardist and especially if they are located within easy access of good markets, they may often be made very profitable by

skillful management and good business methods. Under such conditions liberal feeding is generally the rule and the deficiencies of the natural environment are offset as much as possible by extra care.



Photo by J. G. Boyle.

Fig. 6. Nursery tree affected with crown-gall. Trees showing this disease in the root-system should not be set.



Photo by J. G. Boyle.

Fig. 7. A splendid distribution of branches on a four year old apple.

For the home orchardist it is generally possible and certainly preferable to select soil that is good enough to grow fair crops. A liberal amount of plant food present in the soil in available form, is a

great advantage in giving the young trees a vigorous start during the first few years after setting.

A well drained soil with good elevation, slightly higher if possible than the surrounding area, fairly heavy in character, with a deep, strong but not hard-pan sub-soil, furnishes the best condition for successful apple growing.

It is not always possible to make all the conditions ideal. It



Photo by J. G. Boyle.

Fig. 8. An apple tree with a well-formed head. The scaffold limbs are well distributed and the crotches strong. Compare with Fig. 9.

may even be desirable for the home orchardist to sacrifice certain advantageous features for the sake of securing others which the commercial grower would not consider. For the protection of the fruit and for convenient harvesting, most people want the home orchard near the house. Because the ground is level, don't think that it will not grow good fruit. Level ground is not ideal on ac-

count of the considerations discussed above, but one of the best orchards in the state is on nearly level ground on black soil. This place has good drainage and a clay sub-soil, however. Do not on any account, even for the home orchard, set the trees on land that is lower than that which surrounds it. The writer has in mind a 70 acre orchard not 50 miles from the Experiment Station, which was set in a low, flat pocket. At last accounts the trees had never yielded a half crop.

A heavy soil, though more desirable, is not essential for the home orchard. With some attention, apples will do well on soil that is generally considered too light for the purposes of the commercial orchardist. The trees will not be so long lived, but with some feeding they will bear for many years.



Photo by U. C. Allen.

Fig. 9. Don't allow the head to develop in this way. Such over-crowding can be prevented by correct early pruning but is difficult to remedy later.

Selection of varieties.—The considerations which govern the choice of varieties for the home orchard are very different from those which present themselves to the mind of the commercial fruit grower. The first question which the commercial grower asks is, "What varieties pay best"? The amateur in choosing varieties for his home orchard is privileged to ask the question first of all, "What varieties do I like best"? The home orchard should contain those varieties for which the owner has an individual preference, so far as his condition of soil and climate allow him to attempt their culture. Varieties selected on this basis are likely to receive better care and hence to yield better results, than a list containing many unfamiliar sorts, made up at the suggestion of the artful and enthusiastic tree peddler. Reliable nurserymen may generally be trusted for information concerning the adaptability of given varieties to conditions in their locality. Sometimes, however, they are inclined to judge a variety by its adaptation to cheap and easy production in the nursery, rather than by its value for the home orchard.

The home orchard should be a place where quality receives consideration. Many of the widely known standard market sorts are high quality varieties, but there are many which are strongly favored



Photo by J. G. Boyle.

Fig. 10. First step in the use of the planting board. The middle stake marks the future position of the tree.

by commercial growers which deserve little if any place in the home orchard. There is little wisdom in growing fruit for the home of only medium quality, when with no more trouble or expense the orchardist can produce some of the cherished and well-remembered favorites of his boyhood, or some of the later varieties which are celebrated for their flavor and quality.

The varieties for the home orchard should be so chosen as to furnish fruit enough for family use during as long a season as possible. There should be at least a sample of some of the earliest sorts, with such a succession of ripening, that the latest may be kept till the early ones ripen the following season. In the home orchard the number of varieties may wisely be made greater than is practicable in the commercial plantation, and in fact is limited only by the disposition of the owner.

The diversity of conditions between the northern and southern parts of the state make it impossible to recommend a list of varieties which will do equally well in both. Some varieties are of such excellence and adaptability that they may be safely planted almost anywhere in Indiana. The conditions also of some parts of the state, especially the east central are such, that nearly all standard varieties thrive. The following lists are short and are intended to be suggestive rather than exhaustive. Some prospective orchardists will

miss favorite varieties; some fruit growers will have sorts growing well which are not included, and some may find certain varieties included which are not adapted to the conditions of their immediate locality.

The list is derived from the records of the Department of Horticulture of the Experiment Station, the studies carried on by



Photo by J. G. Boyle.

Fig. 11. The board was removed and the hole dug without moving the end stakes. The tree placed in the notch, occupies exactly the position held by the stake. Work dirt in carefully about the roots.

the Bureau of Pomology of the United States Department of Agriculture, the reports of various skilled fruit growers in the state as recorded in the transactions of the Indiana Horticultural Society, and from the investigations and observations of the writer in studying the orchard conditions of the state.

The United States and Canada have been divided into horti-

cultural districts, according to similarity of soil conditions, climate, rainfall, elevation, etc. The northern part of Indiana falls in one of these districts; the southern part in another.

The division of the state at the 40th parallel of longitude fol-



Photo by C. G. Woodbury.

Fig. 12. Another convenient home-made truck for the barrel pump; very good where trees can be reached from ground. Only one horse is needed. Note also the long lead of hose; 25 feet is not too much.

lows the division of the American Pomological Society. This line is about 15 miles north of Indianapolis, and passes through Vermilion, Fountain, Montgomery, Boone, Hamilton, Madison, Henry and Wayne counties.

VARIETIES RECOMMENDED FOR THE HOME ORCHARD.

1. For Northern Indiana.

Name and Use.	Season.
Alexander (Emperor Alexander*) Kitchen, Market	Medium
Bailey Sweet (Patterson Sweet) Dessert, Kitchen, Market	Medium
Baldwin (Red Baldwin) Dessert, Kitchen, Market	Late
Bough (Sweet Bough) Dessert, Kitchen	Early
Chenango (Chenango Strawberry) Dessert, Market	Medium Early
Early Strawberry (Red Juneating) Dessert, Market	Early
Esopus (Esopus Spitzenberg) Dessert, Kitchen, Market	Medium Late
Fameuse (Snow, Snow Apple) Dessert, Kitchen, Market	Medium Early
Golden Russet (English Golden Russet) Dessert, Kitchen, Market	Late
Golden Sweet (Orange Sweeting) Kitchen, Market	Medium Early
Gravenstein (Early Congress) Kitchen, Market	Medium
Grimes (Grimes' Golden) Dessert, Kitchen, Market	Medium Late
Hubbardston (Hubbardston Nonsuch) Dessert, Kitchen	Medium Late
Jefferis (Everbearing, Grantham) Dessert, Market	Medium Early
Jonathan (New Spitzenberg) Dessert, Kitchen, Market	Medium Late
McIntosh (McIntosh Red) Dessert, Kitchen, Market	Medium Late
Maiden Blush (Maiden's Blush) Kitchen, Market	Medium
Northern Spy (Spy) Dessert, Kitchen, Market	Late
Oldenburg (Duchess of Oldenburg) Kitchen, Market	Medium Early
Red Astrachan (Abe Lincoln) Dessert, Kitchen, Market	Early
Roxbury (Roxbury Russet) Kitchen, Market	Very Late
Shiawasee (Michigan Beauty) Dessert, Market	Medium Late
Tolman (Tolman Sweet) Dessert, Kitchen	Very Late
Tomkins King (King of Tompkins County) Dessert, Market	Late
Wagener (Wagoner) Dessert, Kitchen, Market	Late
Wealthy, Dessert, Market	Medium
Williams (William's Favorite) Market	Medium Early
Yellow Transparent (White Transparent) Dessert, Kitchen, Market	Medium Early

Crab Apples.

Hyslop (Hyslop's).
Martha.
Transcendant.
Whitney (Whitney No. 20).

*The names included in parentheses are synonyms. The nomenclature is in accordance with the rules adopted by the American Pomological Society.

2. For Southern Indiana.

Name and Use.	Season.
Arkansas (Mammoth Black Twig) Kitchen, Market	Late
Ben Davis (Carolina, New York Pippin) Market	Late
Benoni, Dessert	Medium Early
Bough (Sweet Bough) Dessert, Kitchen	Early
Buckingham (Fall Queen, Byers' Red) Dessert, Kitchen, Market	Medium Late
Buncombe (Red Winter Pearmain) Dessert, Kitchen	Late
Chenango (Chenango Strawberry) Dessert, Market	Medium Early
Early Harvest (Prince's Harvest) Dessert, Kitchen	Very Early
Gano (Black Ben?) Market	Late
Gideon, Kitchen, Market	Medium
Golden Sweet (Orange Sweeting) Kitchen, Market	Medium Early
Gravenstein (Early Congress) Kitchen, Market	Medium
Grimes (Grimes' Golden) Dessert, Kitchen, Market	Medium Late
Horse (Yellow Horse) Kitchen, Market	Medium Early
Ingram (Ingram's Seedling) Dessert, Kitchen, Market	Very Late
Jefferis (Everbearing, Grantham) Dessert, Market	Medium Early
Jonathan (New Spitzenberg) Dessert, Kitchen, Market	Medium Late
Limbertwig (Red Limbertwig) Dessert, Kitchen	Very Late
Maiden Blush (Maiden's Blush) Dessert, Kitchen, Market	Medium
Oldenburg (Duchess of Oldenburg) Dessert, Kitchen, Market	Medium Early
Ralls (Janet, Rawle's Genet) Kitchen, Market	Very Late
Rambo (Bread and Cheese) Dessert, Kitchen	Medium
Red Astrachan (Abe Lincoln) Dessert, Kitchen, Market	Early
Red June (Carolina Red June) Dessert, Market	Early
Red Stripe (Carolina Red Stripe) Dessert, Kitchen, Market	Medium Early
Rome Beauty (Gillett's Seedling) Dessert, Market	Medium Late
Stayman Winesap (Stayman) Dessert, Market	Late
Wealthy, Dessert, Market	Medium
White Pippin, Dessert, Kitchen, Market	Late
Winesap (Winter Winesap) Dessert, Market	Very Late
Yellow Transparent (White Transparent) Dessert, Kitchen, Market	Medium Early
York Imperial (Johnson's Fine Winter) Dessert, Market	Medium Late

Crab Apples.

Florence.
Hyslop (Hyslop's).
Red (Red Siberian).
Transcendent.

Buying the trees.—The question is occasionally asked if it is not better and safer for the fruit grower to grow his own trees than to buy them. For the small planter this is not to be recommended. The saving of time alone would justify the buying of the trees if nothing else were considered. All practical orchard men know that

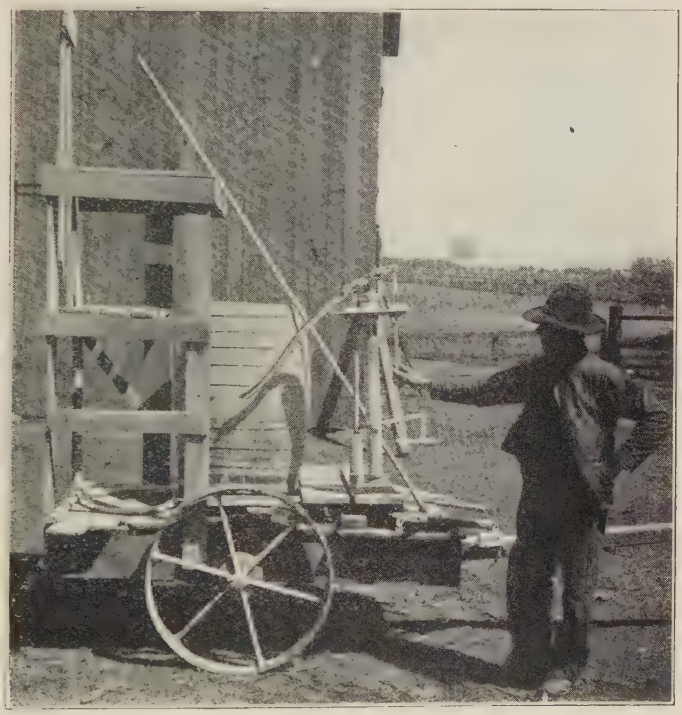


Photo by C. G. Woodbury.

Fig. 13. Old mower wheels were used in this home-made mounting for a barrel pump, and a tower was made of rough lumber. Such an outfit costs little and is capable of good work.

the average output of the average nursery is not always everything we would desire. With proper precautions, however, the buyer can protect himself and unless he is an expert and is devoting his whole time to the orchard business, he can buy better trees than he can grow. Good trees are grown by nurserymen; they usually cost more than mediocre or poor ones, but are far cheaper in the end.

What shall we demand in nursery stock? The planter has a right to demand trees that are healthy and free from injurious in-

sects and diseases. The state inspection law removes the likelihood of the trees being infested with scale or crown gall. The young trees should be in good condition when they arrive. Ordinarily nursery stock is dug in the fall and kept in a storage house during the winter, so as to be ready for the usual rush of spring delivery. If properly stored, the trees will come out in spring ready for planting with no loss of vitality. If the bark is shrivelled and hard,



Photo by J. G. Boyle.

Fig. 14. A Vermorel nozzle.



Photo by J. G. Boyle.

Fig. 15. Two types of "Friend" nozzle.

seeming very tight to the wood, or if it is loose so that it strips off readily, the tree should not be planted.

The young tree should be well formed, straight and clean, of a good size for the age, and of a good shape for the variety. Allowance must be made, however, for the fact that some varieties naturally make much more symetrical tops than others. Winesap for instance, is much less inclined to make a good symetrical growth in the nursery row than Ben Davis. The characteristic varietal habit of the tree should be kept in mind in judging its quality. Weaklings, very slender and crooked trunks, stunted or unhealthy trees should not be accepted for planting.

Some buyers make the mistake of planting trees which are too old. Four, five or even six year-old stock is not infrequently preferred by the inexperienced planter, who seems to be under the impression that he is investing in forestry rather than fruit. Such trees are liable to be the culls from which the better trees have previously

been selected; they are nearly always headed too high, they suffer more from transplanting than younger stock, and the natural defects of habit which they may have developed are much more difficult to remedy. They should by all means be avoided.

It is the judgment of the most experienced orchardists that two- or three-year stock is best for setting. At present the preference is rather for the younger of these.

When to set.—Definite advice on this point, which will always prove best to follow, cannot be given. Briefly, the situation is like



Photo by J. G. Boyle.

Fig. 16. Modified type of Vermorel.

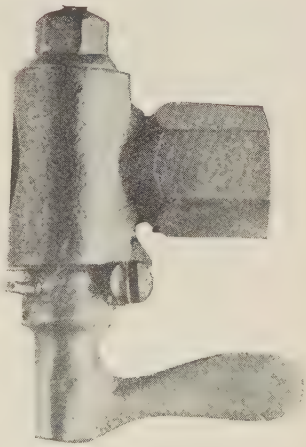


Photo by J. G. Boyle.

Fig. 17. Small Bordeaux type of nozzle.

this: in a good season fall setting is preferable. The trees have several months in which to become established in the soil, and can begin to grow in the spring long before the ground is dry enough to work. At that season too, time is not so valuable and the work can generally be done cheaper. On the other hand, fall setting may be followed by considerable injury if the trees are put out at the close of a dry summer when there is but little moisture in the ground. Especially, is there liable to be a good deal of winter killing, if under such conditions, a cold dry autumn ensues followed by a severe winter. Balancing the various considerations, one against the other, it

is apparent that there is little choice. Usually there is a slight advantage with the fall set trees.

Occasionally fall set trees suffer from cold before they are set in the ground. The roots should on no account be exposed to freezing weather. It is the cold and lack of moisture which cause the damage. On this account fall set trees should not be cut back till the following spring. (See page 22).

Caring for the young trees before setting.—So many young trees are lost through careless handling, that a word here about

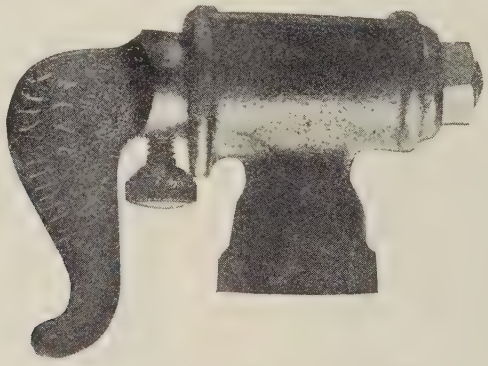


Photo by J. G. Boyle.

Fig. 18. Large sized Bordeaux nozzle. (Deming Co.) (See text for discussion.)

caring for the stock from the time it is received till planting time, may not be out of place. As soon as the trees are delivered they should be unpacked. They may have been on the road for several days and possibly they are getting dried out. If the land has previously been made ready, they may, of course, be set at once. Frequently, however, several days or even weeks may intervene between arrival and setting. Unless they are set at once, they should be unpacked, the bundles cut, and the trees "heeled in". Care should be taken right here to keep the varieties separated and to avoid mixing the labels. A shallow trench should be dug and the trees laid in it close together in a slanting position. Damp soil should then be packed, not simply thrown, about the roots, and thoroughly firmed above them. After this is done a few more spadefuls may be thrown over loosely to help check evaporation. Many prefer to point the top to the south to prevent the rays of the sun striking so directly on the exposed trunks. Heeled in this way, the young trees may wait planting for a considerable time without injury.

Preparing the soil for the tree.—Wherever the character of the

land will permit, thorough and deep working should be given before the trees are set. The surface should be made fine and friable. Sometimes it may be necessary to set trees in sod because of the steepness of the land. If this is done, they should be thoroughly mulched as soon after setting as possible. Cultivation before setting



Photo by C. G. Woodbury.

Fig. 19. A commercial orchardist's Bordeaux mixing plant. Such a plan for the use of pond water may often be modified to advantage by the home fruit-grower.

to get the land clean and to give the trees the best start possible, should be the rule. Other methods are exceptions.

In the matter of laying out the orchard, there is apt to be considerable difference between the methods of an experienced commercial grower with a large acreage and several setting gangs, and the methods of the home orchardist with comparatively few trees. For the home grower "slow and sure" is a better motto than "quick

and cheap". On fairly level ground it is possible to lay off the orchard with considerable accuracy and at the same time save some labor in digging, by plowing furrows in one direction as far apart as the rows are to be, and then marking across the field in the other direction with a corn marker so that the intersections will indicate where the trees are to stand. A skillful planter can locate the tree by simply measuring, sighting and setting stakes. For the small



Photo by C. G. Woodbury.

Fig. 20. A simple home outfit for boiling lime-sulphur wash for San Jose scale.

orchard it is a good plan to set stakes and see that they are in accurate alignment, with a stake for each tree. The methods by which the stakes are set is immaterial.

Various systems of planting such as the quincunx, hexagon, etc., are used, by which a few more trees can be secured per acre and the distance in every direction from one tree to another be made equal. The square is simpler to lay out, and for most purposes preferable unless it be modified by the setting of temporary fillers in the center of the squares.

Don't set the trees too close. They should not in any case be closer than 32 feet; 36 feet is better, and 40 feet apart is, for most Indiana soils, better still. A sketch should be drawn off on paper showing the plan of the orchard and a list of the varieties it contains, with their location. Much inconvenience may often be avoided later if such a plan is made and in any case it is always a source

of satisfaction to be able to identify all the varieties with certainty as they come into bearing.

Preparing the tree for the soil and pruning.—Take the trees up from the heeling in trench, being careful again to keep the varieties separate and all the variety labels plain. The first thing is to prune

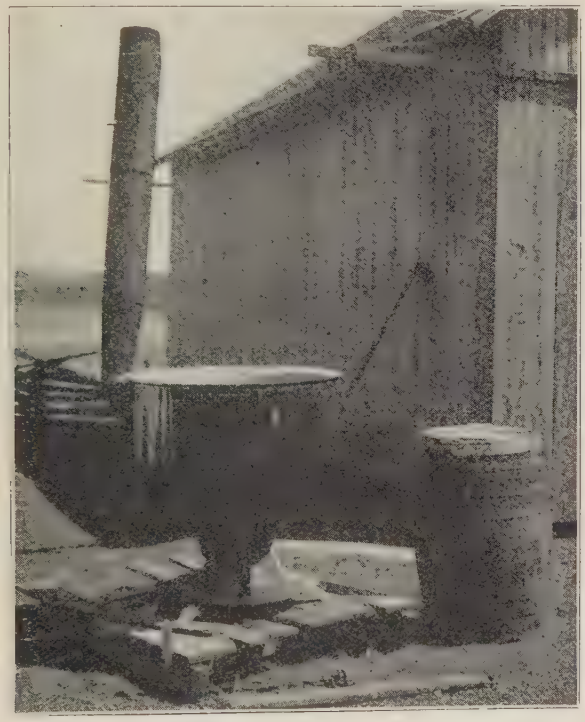


Photo by C. G. Woodbury.

Fig. 21. An old iron feed cooker is excellent for the home preparation of lime-sulphur wash. The fire is concentrated and easily controlled and the spray can be conveniently handled.

the roots. There has been a vast amount of discussion about this matter of root pruning, and considerable confusion remains in the minds of a good many fruit growers. Some planters are fearful that the trees will be permanently injured if any considerable part of the root-system be removed. Some are advocates of the Stringfellow system and want to remove about all the roots. The battle of words brought about by the heretical Stringfellow doctrine has accomplished much good. Now that the smoke has cleared, the

practical fruit grower can see that the truth lies with the extremists on neither side. Stub-root pruning is not necessary, nor for all soils, advantageous. On the other hand, a large proportion of the root-system may be removed, and if the tree is handled well in other respects, it will develop as well as if left with all the roots which survived the original digging. If the roots are dense and fibrous, thin them out; if, as is often the case, there are long stragglers



Photo by C. G. Woodbury.

Fig. 22. Winter cocoon and larva of the codling moth, slightly enlarged, on a bit of apple bark. The larva pupates here after hibernating and comes out an adult moth, to lay eggs for the first brood.

which make planting awkward, cut them off. Remove all unhealthy, dead or broken roots. A glance at Fig. 4 will give a general idea of what may be termed the "common sense" method of root pruning. The specimen shown might be still further shortened without injury. A point which it is as well to observe is to make the cuts on the under side of the roots. This brings the cut surface down and is said to induce a better growth of new roots.

If the trees are set in spring, it is often more convenient to prune the top also before setting, than after. If fall setting is practised, the heavy first pruning should be deferred until spring. It has been demonstrated very clearly that drying takes place much more rapidly from the cut surface of a limb than from the unbroken bark. Fall-set trees are likely to suffer severe winter injury if the cut surfaces are exposed to the cold drying winds of fall and winter.

This first pruning is of the greatest importance. It must be done and it is important that it be done as well as possible. Many planters do not realize that when a tree is dug from the nursery

row, the greater part of the root-system is left in the ground. What happens then if our young tree be not pruned? Here is a large leaf bearing growth developed to correspond to the food gathering ability of the roots in the soil below. The plant food taken up by the root in dissolved form is drawn up to the leaves where moisture is given off and the food changed in some manner by the green substance of the leaf and converted to the use of the tree. Suppose we leave half



Photo by C. G. Woodbury.

Fig. 23. Just after the petals fall and before the calyx lobes close up, is the stage of bloom at which the most important spraying for codling moth should be done.

the tiny white, fibrous rootlets, which alone are useful as food gatherers, in the soil of the nursery and plant our tree without further treatment. A large leaf surface will be developed from which moisture will be evaporated faster than the crippled root-system, not yet thoroughly established in the soil, can supply it. The result is that the tree is literally dried up. Nature had a balance between top and roots. We have been compelled to destroy that balance in digging the tree from the nursery row, and so depriving it of most of its feeding rootlets. We must restore it by likewise removing a large proportion of the top so that the leaf bearing wood we leave, will be well furnished with food and moisture and start into vigorous growth.

If one year stocks are used for setting, they may be pruned to whips. If two or three year old stocks be used, the head can generally be saved, provided it is well formed. It is usually the best practice to cut off the side branches to stubs a couple of inches long, and to shorten the top about one half. If a large number of side branches are present, most of them should be removed entirely, leaving three to five stubs well distributed to form the scaffold limbs. Do not allow all the main branches to spring from the trunk at practically the same distance from the ground. Some of the limbs are certain to be badly crowded. Fig. 9 shows a top from which it is impossible to remove a branch in such a way that the wound will heal over. In Fig. 8 we have a top which is much less liable to break down, and from which, if the future development of the tree should require it, any branch can be easily and safely removed. The second season's pruning will consist in simply removing the extra branches so that the leaders which have been selected to form the top, will not have too much competition. If the trees are good and have been well started, the subsequent pruning will not be difficult. Study the individual trees and watch their development, cut out the water sprouts, keep the tops fairly open, remove crossing and interfering limbs, prune regularly and systematically.



Photo by C. G. Woodbury.

Fig. 24. Method of banding trees to catch codling moth larvae. The bands should be left from June till August with removal every 10 days to kill the larvae beneath.

Setting the trees.—During the time that the trees are being set, it is well to protect the roots by puddling. If the soil or sub-soil is of a clayey nature, this is not difficult. Simply dig a hole about two feet deep and put in soil and water until a thin mud is obtained. If

the roots of the trees are dipped in this, they are coated thinly with mud, and are less liable to be injured by drying before they are set.



Photo by B. R. Ryall.

Fig. 25. Apples badly affected with the scab fungous. The fruit is hard and knotty and the surface cracked. Spray with Bordeaux to control scab.

The small planter, especially if he be inexperienced, will do well to use the old fashioned planting board. The planter of thousands will probably regard this method as too slow, and will rely upon careful sighting to get his trees in line. After the stakes have been placed showing the future position of the tree, the problem is to dig the hole and set the tree exactly where the stake was. This is easily accomplished with the planting board, which is simply a six inch board, four to six feet long, with a notch on one side of the center of the board, and a notch at each end. The tree stake is fitted to the center notch with the board laid on the ground, and small stakes thrust into the ground at the end notches. The board and tree stake are now removed and the hole dug. The board is

replaced with the tree trunk fitting the central notch instead of the stake and held in exactly the same place. Fig. 11 illustrates the use of the planting board.

In digging the holes, it is a good plan to throw the good top soil by itself, then when the tree is set, this soil may be put about the roots. The hole should be deep enough to allow the tree to be set about two inches deeper than it stood in the nursery row. Be sure to get the soil packed thoroughly about the roots. This is absolutely essential. The first earth should be tamped in carefully but firmly. *Don't* leave an air space under the crown. Don't tramp the earth so hard and so carelessly that the bark is taken off the roots in the process. On the top, a little soil should be left loose. Thorough packing below will cause the soil moisture to come up about the roots by capillary action; the loose earth on top will tend to check surface evaporation and keep the moisture in the soil.



Photo by C. G. Woodbury.

Fig. 26. At this stage, just before the flower buds open, spray with Bordeaux mixture to control the scab fungous.

Trees sometimes suffer from sun-scald and from the attacks of mice and rabbits. To guard against these troubles, some mechanical protector made of veneer or wire screen is usually the best safe guard.

In situations which are considerably exposed to the sweep of winds, it is well to lean the young tree at planting, slightly in the direction of the prevailing winds, usually to the southwest. So set, the trees will stand straight when mature instead of leaning in the opposite direction. It is a very good practise to plant a wind break for the protection of such sites. A double row of catalpa or other useful tree will furnish the desired protection and may later be converted into a source of profit.

Double cropping.—For the first few years, the trees will not occupy nearly all the land and the question often arises as to the desirability of using the space between them for other purposes. Will it pay? Is it good for the trees? And what crops, if any, can be grown? On fairly level ground which is not subject to washing, it is often profitable to grow crops in the home orchard for two, three, or even four years, provided always the fact be kept in mind, that the area is an orchard, first of all, and that the trees are the main consideration. Low growing garden crops are good for this purpose, and will not materially injure the young trees. Potatoes make an excellent crop for the young orchard. They do not materially rob

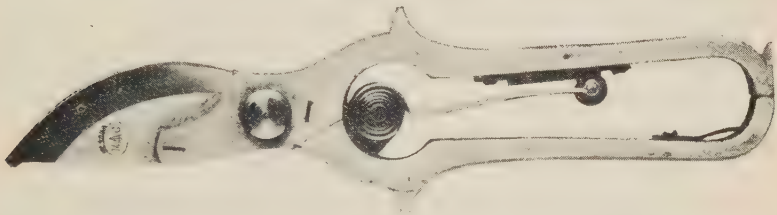


Photo by J. G. Boyle.

Fig. 27. One of the most satisfactory types of hand pruners. All the work around the young orchard can be done with this tool.

the soil, the cultivation they require is good for the trees, and they leave the ground loose and in good condition. Strawberries are also frequently grown with success. If neglected, however, they are liable to be a source of considerable damage. The planter who allows his strawberries to run wild and fill up the ground, would probably neglect the orchard likewise, and would better not grow fruit at all. Corn is sometimes grown for a year or two, but in the opinion of the writer, is less desirable than either of the other crops mentioned. Corn is very greedy of water and if planted close to the young trees, will rob them of their proper share. Some argue that the trees are benefited by the partial shading. The writer prefers to protect his trees from sun-scald by some means other than by overshadowing them with a corn crop. If properly handled and kept away from the trees, which, however should be cultivated as often as the corn, this crop may be grown for a year of two without serious detriment.

Small fruits such as raspberries or currents are sometimes grown to advantage in the young orchard. They must be kept strictly within bounds, however, and will sometimes need to be removed before they have outlived their usefulness. For an orchard crop, it is probably better to hill berry plants so that they may be cultivated in both directions. For a discussion of the methods of growing small fruits, see Bulletin No. 128.

Tillage versus sod mulch.—In recent years there has been a good deal of controversy in various parts of the country between the exponents of different systems of orchard management, each claiming that his own method produced the best results. A great many fruit growers have been heard from, and many opinions have been advanced. Some careful experimental work has been done, but until we have a good deal more definite data than is now available, worked out carefully under the conditions that surround Indiana fruit growers, we shall have to suspend final judgment on this important problem. We may, however, allow, ourselves to state the problem and advance our own opinions along with the others, basing them on what information we have, which applies to our own conditions.

For the most part, these questions are of primary importance to the commercial grower and are of secondary interest to the owner of a home orchard. With the latter, such questions as the growing of other crops in the orchard, the use of the orchard for pasture, or



Photo by B. R. Ryall.

Fig. 28. The old-fashioned pruning knife. A useful tool for light work.

for a poultry lot, enter in and make him less inclined to follow any rigid system of orchard management. The home orchardist often finds that a system of management which does not embody the last refinement of skillful fruit growing, may be the most profitable for him to follow, owing to the incidental benefits he may derive from his orchard plot.

There are some general considerations, however, which always apply, and these it may be well to mention briefly. If the orchard is situated on land which if cultivated would be liable to wash badly, regular tillage is out of the question. For such orchards mulching, either with material grown in the orchard or with material brought in and spread about the trees, is the only safe method to follow. In order to compensate for the lack of tillage this mulching material must be plentifully applied. On land which is not subject to washing and where the aim is solely the production of the greatest amount of good fruit, the writer advocates clean cultivation during the early part of the season, to be followed by a cover crop during the winter. This may be clover, crimson clover, vetch, cow peas or oats, and should be sown about the middle of July and turned under

the following spring. In sections where apples are subject to fire blight, this clean cultivation may need to be modified. It may even be necessary for a time to keep the orchard in sod. (See Bulletin No. 118). This clean-culture, cover crop method is giving the best results to most fruit growers at the present time, and is in harmony with the best farm practice in other directions.*



Photo by B. R. Ryall.

Fig. 29. A good kind of two handed pruning shears. Best for limbs from an inch to an inch and a half in diameter and much more rapid than the saw.

III.—HOW TO SPRAY AND HOW TO PRUNE THE HOME ORCHARD.

Spraying.

A discussion of the reasons for spraying and an explanation of its necessity, together with a classification of fruit pests and directions for their control may be found in Bulletin No. 118 of this Station, hence it is not considered necessary to repeat the information in the present circular. It will be assumed here, that the home orchardist not only knows that spraying pays, but that he knows that thorough, careful and intelligent spraying is absolutely necessary nowadays to the production of good fruit. It is conceived further that the home orchardist is more interested in knowing how and when to spray and what to spray with, than in a long list of tree diseases and orchard insects, nine-tenths of which he will

*For a discussion of these questions, the reader should consult Ohio Bulletin No. 171, and New York (State) Bulletin No. 314.

control unconsciously if he will intelligently concentrate his efforts upon the remaining tenth.*

The spraying outfit:—Granted then that spraying is to be done, the first question to be decided is what kind of an outfit is the best and cheapest to procure. Where spray outfits are concerned, the best is usually the cheapest. It is unfortunate that at the present

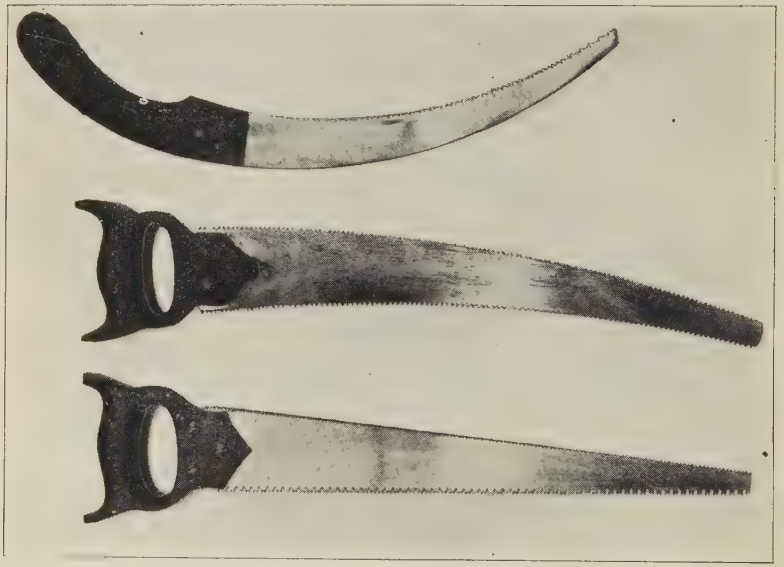


Photo by B. R. Ryall.

Fig. 30. Different styles of pruning saws. For ordinary work the middle one is handiest; for heavier work the bottom one. In removing a large limb make a cut on the under side first to avoid splitting.

time, the demand for spray pumps and accessories of good quality is not great enough outside of certain restricted fruit growing communities to warrant dealers in carrying them in stock. The makeshift appliances carried by the general hardware or implement dealer are, as a general rule, sold only because they are inexpensive, to men who do not understand the requirements of a good machine and are totally unfit to do efficient and satisfactory work in the orchard. Unless the local dealer carries some makes of spray pumps that

*The San Jose scale is one of the most serious enemies of Indiana fruit trees. This insect together with many other orchard pests is fully discussed in Bulletin No. 118 of this Station, to which the reader is referred for further information.

are standard and in demand by experienced fruit growers, the writer would advise the prospective buyer to write direct to several manufacturers for their spray pump catalogues and prices. From these it is not difficult to select an outfit that will be serviceable, efficient and cheaper in the end than the kind it is usually possible to buy at the store. After a selection is made from the catalogue, it may often be of advantage to purchase through the local dealer.



Photo by J. G. Boyle.

Fig. 31. Pruning with an axe is a common tree crime in the neglected home orchard. Such wounds won't heal over, and will shorten the life of the tree.

The following short list of spray pump manufacturers may prove helpful. It includes by no means all the makers of good spraying outfits, and is offered simply as a suggestion. Other good makes are advertised in the horticultural press.

Morrill and Morley, Benton Harbor, Mich.
Deming Co., Salem, Ohio.
Hardie Manufacturing Co., Hudson, Mich.
Friend Manufacturing Co., Gasport, N. Y.
Gould's Manufacturing Co., Seneca Falls, N. Y.
Spramotor Co., Buffalo, N. Y.
E. C. Brown Co., Rochester, N. Y.

For the home orchard, experience has shown that the barrel pump is the most useful all-round type of machine. It consists simply of a pump which can be mounted firmly in any good 50

gallon barrel. An oil or whiskey barrel is most useful for this purpose and will last for years. It is better to have about the largest size pump which is made for barrel use, as the pressure can be kept up more easily, and it is not such hard work for the man at the pump handle. Whatever the make of pump used, it is

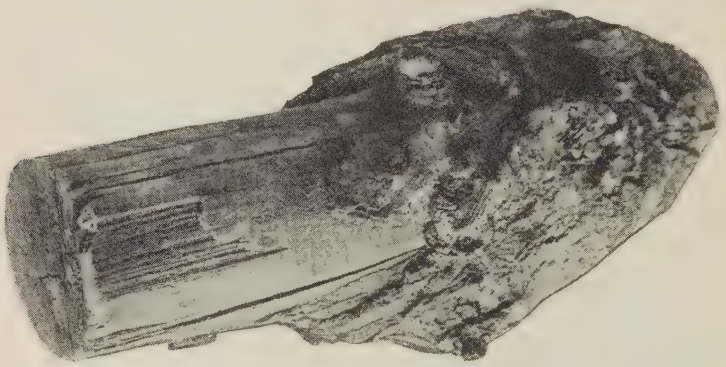


Photo by J. G. Boyle.

Fig. 32. An example of thoroughly bad pruning. The cut was not started on the underside, hence the limb splintered badly. The stub was left too long, and could never heal.

economy to get good quality. The spray mixtures used are corroding to iron, so that all parts of the pump which come in contact with them should be of brass. A good mechanical agitator which is worked with the pump handle, is necessary to keep the spray mixture thoroughly stirred up. Beside the pump, a lead of hose, which is made especially for spraying purposes, is required. Most manufacturers supply a lead of hose six or eight feet long with the pump. This is not enough. To work easily and conveniently, at least 25 feet should be procured. In order to get the spray up into the tree an extension rod of bamboo should be provided. These are made in various lengths from six to 12 feet. The eight foot length is of the most all-round usefulness. The bamboo is lined with brass tubing and is light, rigid and durable. At the butt of the rod is a stop-cock, so that the spray may be instantly shut off or turned on. At the end of the extension rod is located the spray nozzle. The nozzle is a very important part of the outfit and should be selected with considerable care. Several different types are now on the market, which give excellent satisfaction. The old standard Vermorel type shown in Fig. 14 is very good. The design known as the Bordeaux nozzle also gives good results in the hands of a skillful sprayer. Some of the other types which are giving good results are shown in Figs. 15, 16, 17 and 18. A perusal of the

makers' catalogues will reveal several other styles, which may be used satisfactorily. A strainer of good brass mesh should be at hand, and all mixtures containing lime should be poured through; otherwise small unslaked particles will get in and clog the nozzles.

Fig. 12 shows a barrel pump which has been in use at the Experiment Station for several years. The lead of hose and extension rod may also be seen. The pump shown in this cut is mounted on a home-made truck, which is very convenient to use where

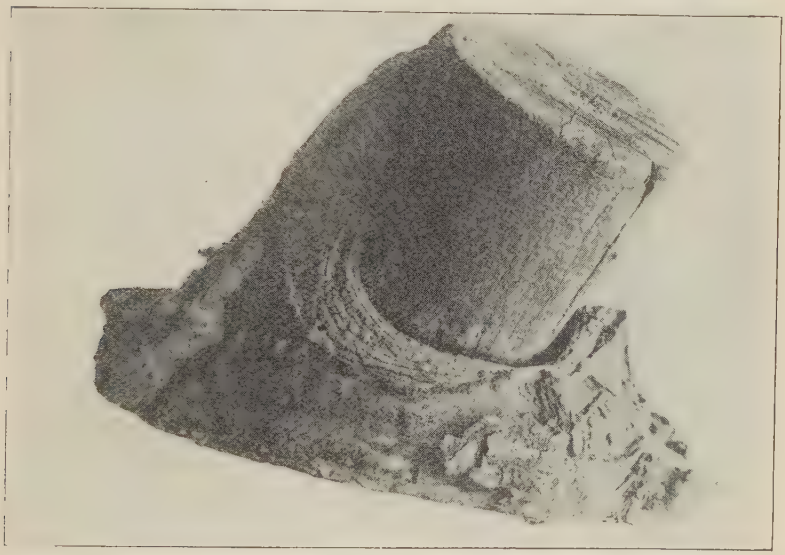


Photo by J. G. Boyle.

Fig. 33. Too long a stub to heal over. The tree evidently tried hard but could not cover the wound with healing callous.

the trees are low enough so that all parts can be reached with the extension rod from the ground. If the trees are too tall for this, the man with the spray rod must be elevated in some way. The barrel and pump may be put in a wagon, or a tower may be built on the truck. Fig. 13 shows another home-made truck mounted on old mower wheels and with a tower which enables the operator to reach the top of good sized trees. Other devices will suggest themselves which can be made with little trouble with the material at hand. It is not so much the means as the results we want in spraying, and just as good work can be done with such outfits as are shown, as can be done with the most expensive power sprayer on the market. The cost of the kind of outfit shown in Fig. 12

including pump, barrel, strainer, hose, rod and nozzle, need not be over $25.00.

Ease and convenience in spraying depend quite as much upon the facilities which are provided to make the spray mixtures with, as upon the outfit used in applying them.

Before starting to make Bordeaux mixture* be sure that you have two or three barrels on hand that will hold water. A box to slake lime in is convenient also. Fig. 19 shows a very convenient home-made outfit for making Bordeaux in large quantities rapidly and conveniently. The barrels are mounted on a platform so that dipping is not necessary, but the mixture flows directly into the spray tank. The water furnished by a pond or stream, is just as good for this purpose as well water** and often more convenient to use. A cheaper adaptation of the plan shown in Fig. 19, without the elevated platform, but with simply a mixing platform and pump, will often meet the requirements of the home orchard admirably.

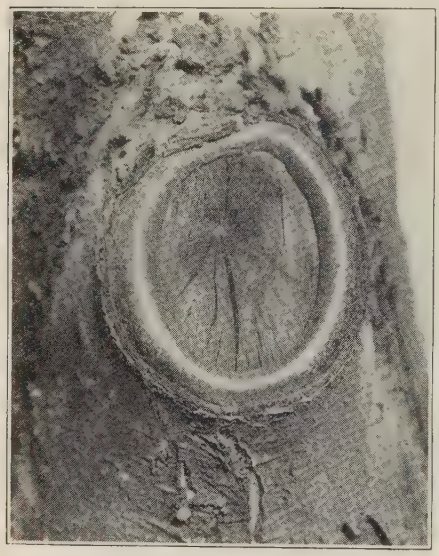


Photo by C. G. Woodbury.

Fig. 34. This wound was properly made and is starting to heal nicely. A good coat of paint should protect the wood until covered with the callous.

For preparing the lime-sulphur wash, which is the standard spray for San Jose scale, various schemes have been worked out. This mixture needs to be boiled. (See Bulletin No. 118). Figs. 20 and 21 illustrate how this may be done with little trouble. In Fig. 20 an iron kettle is simply hung over a trench and a fire kindled beneath it. This is much better and easier to get at than where the kettle is on the surface of the ground and the fire built around it besides requiring much less fuel. One of the most satisfactory small scale outfits for cooking lime-sulphur, which the writer has ever used, is that shown in Fig. 21. It consists of an old feed cooker and holds a 50 gallon iron kettle mounted over an iron fire

*For detailed directions for making Bordeaux, see Bulletin No. 118.
**Bulletin No. 135, University of Illinois.

box. The fire is concentrated, very little fuel is needed, and the whole outfit is most convenient.

There are several brands of ready prepared lime-sulphur washes now on the market, which are very nearly as cheap as the home-made article. The Experiment Station has tested a number of these for several seasons. Not all have given good results, but

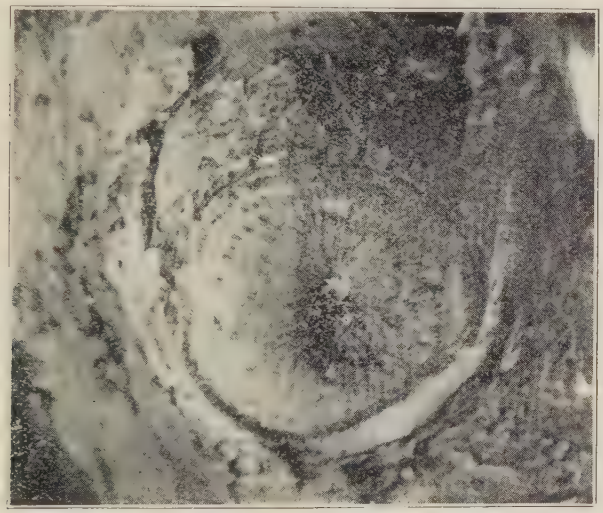


Photo by H. C. Kennedy.

Fig. 35. The last stage in the sealing up of a wound. This follows right pruning and good treatment, and the tree's life is not endangered.

the best are as good as the home-made material, and though a little more expensive are much less trouble to prepare.

How to have wormless apples.—Wormy apples are so common and a crop of sound ones so rare in many of the home orchards in Indiana, that it is difficult for some to realize that they are not inevitable and unavoidable. By a few seasons of intelligent spraying, however, the number can be so reduced that an infested apple is the exception rather than the rule, and the better fruit growers of the state are controlling them with the best of success. The egg which hatches into an apple worm is laid by the codling moth, a small dusky gray insect with wings about the color of the bark of an old apple tree. The eggs are laid in the spring on both leaves and young fruit, and the young worms make their way into the young apples, by far the greatest proportion of them entering at the blossom or calyx end. The spray used to control them is one containing some form of arsenic. Arsenate of lead is probably

the best, though Paris green is very commonly used also. Arsenate of lead commonly comes in a paste or semi-fluid form, and should be used at the rate of from two to three pounds per 50 gallons of water. Arsenate of lead may be prepared at home, but for the small grower this is not advised. If Paris green be used, four to six ounces to 50 gallons of water is sufficient. Unless Paris green is used in Bordeaux mixture, one pound should be combined with two pounds of freshly slaked lime to prevent any burning action on the foliage.



Photo by C. G. Woodbury.

Fig. 36. One of the results of bad pruning. The stubs were left too long and were not protected with paint. As a result, fire-blight has started at the wounds and nearly killed the tree.

The important thing in connection with the codling moth spray, is the time of application. Inasmuch as such a large percentage of the young worms go into the blossom end of the apple, it is very desirable to get the poison in that place before the worm gets there. For this purpose the spraying should take place immediately after the petals fall. Fig. 23 shows young apples in just the right condition for spraying. The petals have just fallen, and the calyx lobes are open. A few days later the calyx lobes close up and it is difficult to lodge any spray in the blossom end of the apple. This first spraying should be as thorough as it can be made. Take time, keep the spray nozzle moving about and get at the tree from every direction. Try to put some spray in the blossom end of every young apple.

There is a second brood of codling moths later in the season. In some localities it is found very profitable to spray for these with the same material during the latter part of July. Lay par-

ticular stress, however on the thoroughness of that first spraying. In an old orchard that has been neglected for years, it may not be possible to reach perfection the first season. Spray thoroughly in the manner outlined for three years and satisfactory results are bound to follow.

After the apple worm has reached its full growth it leaves the apple and seeks a place where it may undergo its transformation and become a moth. Cocoons are often spun under the scales of rough old bark or in any place that offers such concealment. Advantage is often taken of this fact when ridding a neglected orchard of the moth, and the trees banded. Strips of burlap or old carpet are excellent for this purpose. Fig. 24 shows a tree banded in this way. The bands should be eight to 12 inches wide. Large numbers of the worms pupate under the bands and may be easily destroyed while in this condition. The bands should be put on early in June and examination made every 10 to 14 days till mid-August.

How to avoid scabby apples.—All are familiar with the small dark patches on apples and pears where the surface is brown and hard, and often slightly cracked open. Sometimes several of these patches run together and cover one side of the fruit, making it knotty and deformed. This trouble is due to a fungous disease commonly called scab, and can be prevented by spraying with Bordeaux mixture. (See Bulletin No. 118). Here, as in the case of the codling moth, much depends on the time the spraying is done. The trouble can't be cured after it appears. Bordeaux spraying is preventive spraying, and the first application should be made in spring just before the buds open. Fig. 26 shows the stage for spraying for scab.

There is nothing antagonistic in the two kinds of spray used for scab and codling moth, and in orchard practice they are usually combined. This means simply that the arsenate of lead is diluted with Bordeaux mixture instead of with water, and this combined double-purpose spray is used for both scab and codling moth; the first time before the buds open, (for scab, the arsenical being of incidental benefit in controlling other leaf eating insects) and after the petals fall, (for codling moth, the Bordeaux in this case being of incidental benefit in additional protection from scab and other fungous diseases). The third application may be made as above suggested for the second brood of codling moth.

Pruning.

Pruning is a necessary part of the annual orchard routine and must be carried on systematically if the trees are to be maintained

in vigor and productiveness. We are past the time when any apology need be made for this operation or the reasons for it explained at great length. Occasionally the individual is met with who decries the process as being unnatural, but some one has pointed out that the pruning done by nature in an overcrowded and neglected orchard is more severe than any of which the most radical fruit grower would dream.

Never-the-less it is in the neglected orchard that nature needs most assistance. Nature prunes by crowding out some of the limbs, but nature takes too long to finish the job. Something has been said about pruning the young trees, and something is said farther on about pruning the neglected ones. Here it is simply desired to indicate how to do the work and to point out some of the ill-effects that follow if it is done wrong.

Time.—As for the proper time for pruning, the old rough and ready maxim "Prune when your knife is sharp" may be still followed with benefit. This means simply that it is better to prune at any time than not to prune at all when the trees require it. For the heavy work of pruning, the taking out of large limbs, the cleaning up of an old orchard, etc., the preferable time, is from late winter to early spring. It is better not to do it too early in the winter on account of the considerations mentioned on page 23.

Tools.—For pruning small trees, some sort of hand pruning shears is the best tool. A very good one is shown in Fig. 27. This makes a smooth clean cut which will heal over readily, and for small trees especially, is preferable to the old style pruning knife shown in Fig. 28. This latter tool is a good and useful one for many purposes, but on young trees, especially if newly set, is liable to pull too hard in making the cut. For removing limbs larger than the hand shears will cut, a two handed implement of the type shown in Fig. 29 is very satisfactory. This is very similar to the tool used in dehorning cattle and will cut easily as large a limb as it can get hold of, the length of the handles supplying a powerful leverage. For still larger limbs the saw is necessary. Good styles of pruning saws are illustrated in Fig 30. The ordinary hand saw is not suitable. There is a very satisfactory type, however, built something like a bone saw, with a thin blade and frame back.

It would seem unnecessary to say that pruning should never be done with an axe, yet a glance at many old orchards in the state, shows at once that this implement has been the principal one used. The results of this method are shown in Fig. 31. Such a stub can never heal over and may leave a wound which will very materially shorten the life of the tree.

How to make the cut.—The manner of making the cut is a simple thing in itself, but of great importance to the future welfare of the tree. On small limbs where hand shears are used, there is little difficulty. The branch should simply be taken off close to the butt. There is always a little collar or swelling at the point where a branch starts, and it is just here that the cut should be made.

Fig. 34 shows the proper kind of pruning. The cuts have been made close and smooth, and the callous ring which the tree throws out is covering the wound nicely. The result of such pruning is shown in Fig. 35 where the wound has completely healed and is covered with sound bark.

Don't leave a long stub; it cannot heal over. (See Fig. 33.) We see what an effort the tree will make before it gives up. The callous had grown out on one side, but couldn't get over the long stub. When cutting off a heavy branch, start the cut on the under side. This is to prevent the branch from splitting when cut nearly through. In Fig. 32 this was not done. The branch split, with the result that the surface was left so rough that a callous could not form. Such a cut would not heal satisfactorily even if made close to the tree.

When a long stub is left it eventually rots, leaving a "knot hole". This catches water and remains moist, furnishing ideal conditions for the rot producing fungi. In a few years more the rotten place extends to the heart of the tree. Eventually only a thin shell of live wood is left, then the tree blows over and the sound limbs are cut up for firewood. The lives of thousands of trees in Indiana are shortened fully one-half by just such careless pruning as outlined.

Cut the stub close. Paint over the wounds with good paint to prevent rot until the tree itself seals up the wound for all time.

IV.—WHAT SHALL WE DO WITH THE NEGLECTED HOME ORCHARD?

Nearly every farmer in Indiana has been or is now interested to some degree in fruit growing. Many have been interested enough to set out a home orchard and then on account of the demands of the other farm work, have neglected the orchard and have allowed it to degenerate until it presents an appearance which the fruit tree lover is pained to see. Many an orchard, set by the passing generation, during its earlier years a source of pleasure and profit, is now apparently in the "downhill of life" and to all appearances good for little. A large proportion of these orchards might, by proper methods, be so rejuvenated and have their youth so renewed that they would again bear good crops of sound fruit. Where this can be done, it is surely much better than to set a young orchard and wait several years for it to begin to bear.

At the present time a revival of interest is taking place in the question of home fruit growing, and many who own neglected orchards are seeking information as to the right thing to be done to restore them to usefulness and how to set about doing it.

Some Reasons for Non-Fruit Bearing.

"How shall I bring my run down, neglected orchard back to a state of profitable production"? is a question which if it were dealt with fully would probably need as many answers as there are neglected orchards in the state. All that the writer can do here is to establish a sort of an average of conditions, and to urge a few considerations that will apply to the greater number of cases. It must be borne in mind, however, that such recommendations are of necessity more or less general, and where further and detailed advice is needed, the orchard owner is urged to correspond directly with the Department of Horticulture of the Experiment Station.

The very first thing to determine is the reason for the existing unprofitable condition. The reason is neglect, of course, but neglect may lead to a great variety of troubles, and we must try to find out just what the troubles in an individual case happen to be before we can remedy them.

Poor site.—It may be that the land is low and poorly drained and that the trees suffer from spring frosts and "wet feet". If so, that piece of ground was never meant for an apple orchard and the best thing to do it to cut the trees at once and get some good firewood at least, and then set out some young trees in a more favorable location. (See page 4).

Exhausted soil.—The trees may have ceased to bear fruit because the land, possibly never any too good, has been called upon to furnish continuous crops of hay or grain as well as to support the trees. It has been shown by pretty conclusive experiments* that apple trees set at the rate of 35 to the acre (which would equal being set 35 feet apart each way) yielding 15 bushels of apples per tree, draw from the soil in 20 crops more than **"twice as much nitrogen, half as much again of phosphoric and nearly three times as much potash" as 20 crops of wheat would remove counting grain and straw with an annual average yield of 15 bushels per acre. Where the trees are compelled to compete with other crops for a supply of food and water, it is no wonder that they sometimes succumb, considering the heavy demand they themselves must make in order to make good yields.

*Cornell Experiment Station, Bulletin No. 103.
**"Fertilizers," Edward B. Vorhees, A. M.

Crowding.—Not infrequently the neglected orchard is unprofitable because the trees are so crowded together that there is a struggle for bare distance between one tree and its neighbor. The results of this crowded condition may be seen in the long leggy tops, climbing skyward like forest trees, in the struggle for light and air. The writer is of the opinion from observations during the last three years, that in fully one-half the orchards in Indiana, the trees are too close together. Such an orchard, with the tops out of reach, and the ends of the branches interlocking, is impossible to care for properly and can never be made to yield satisfactorily while in such a condition.

Defective orchard hygiene.—Beside the conditions spoken of above, there is another whole class of troubles brought about by the omission of those operations of what may be termed orchard hygiene, which are performed by the commercial grower as a matter of course. The trees may be half choked in a thick tough old sod; this sod is liable to harbor mice and rabbits and the trees may be suffering from their attacks as well as from borers, which thrive and multiply under the conditions furnished by heavy sod close up to the tree trunks. Spraying has very likely not been known to the orchard, and what fruit there is, is scabby, deformed and wormy. The San Jose scale, which is one of the worst enemies of Indiana orchards, and which is blotting out the neglected ones every year, may be present doing its deadly work. Pruning has probably been overlooked, or if it has been done at all, it has been done with an axe in a sort of kill or cure way, which left the trees in worse condition than before.

Remedial Measures.

Much is being accomplished nowadays with these old neglected orchards by renovation. By renovation is meant plowing, pruning, fertilizing, spraying, digging out the borers, and in short giving the orchard a thorough "housecleaning."

Pruning.—Where the orchards are planted too close and the tree tops are so high that they are out of reach of the spray nozzle, a rather severe heading in will be of great benefit. This pruning is one of the first things to be considered in the renovating process. It can if necessity compels, be done at almost any time of the year. It is better to do it in the late winter or early spring. The long leggy branches should be shortened in, all the dead wood should be cut out and all the branches that cross and touch each other or interfere seriously in any way, should be removed without hesitation.

It may be that the succeeding season, there will be quite a crop of water sprouts. These may be taken out at any time, but it is

easiest and cheapest to take them out while they are still small and before they begin to crowd the trees. If the feeding is properly balanced, however, there will not be much annoyance from this source.

Cultivation.—After the brush is cleared away (and it is surprising to see how large a quantity of prunings a few neglected trees will yield), the orchard should be plowed and harrowed and the surface made fine. Any one who has broken a twenty-year old blue grass sod in an orchard will appreciate why the trees suffer from it. A few surface roots may be cut by this plowing. Never mind that but go ahead. Get the ground fine and keep it cultivated till mid-summer, then sow a cover crop which will protect the ground till it is turned under the following spring.

Fertilizing.—Along with the cultivation should go a liberal amount of fertilizer. In the use of fertilizer in orchards, you must avoid too much nitrogen. For this reason heavy mulching with barnyard manure is to be recommended only for such orchards as indicate by their small annual growth, and by their scanty and light colored foliage that nitrogen is lacking. For soils of fair natural fertility and where a nitrogen gathering cover crop, such as clover, crimson clover, cow peas or vetch may be grown, the following formula is suggested. *

A thousand to 1500 pounds per acre of a mixture containing one part (100 pounds) each of ground bone, acid phosphate, and muriate of potash. On soils that are somewhat exhausted, 125 pounds nitrate of soda may be used in addition.

In order to get the greatest returns from this fertilizer, it should be thoroughly worked into the soil. This can be accomplished very well, by applying it to the surface just before plowing. The plowing and working of the ground will get the fertilizer pretty thoroughly incorporated and the trees will soon show the beneficial effect of its presence.

After the neglected orchard has been thus treated, an intelligent application of the spray pump will generally complete its cure. For discussion of spray outfits, see page 29.

ACKNOWLEDGMENT.

Acknowledgement is due to Mr. J. G. Boyle, Instructor in Horticulture in the University, and to Mr. B. R. Ryall, Assistant Horticulturist of the Experiment Station for several photographs made under the writer's direction and used in illustrating this circular. The photographs for Figures 9 and 35 were made by Mr. U. C. Allen and Mr. H. C. Kennedy, respectively, graduates of the class of 1909.

*"Fertilizers," Edward B. Vorhees, A. M.

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 18
(Second Revised Edition)

LaFayette, Ind., November, 1916

AGRICULTURAL EXTENSION

II

CORN SHOWS

AND

SELECTING, PREPARING AND SCORING EXHIBITS

A. T. Wiancko C. I. Christie

With the increased interest in corn improvement work throughout Indiana comes an urgent demand for information relative to corn shows, selection and preparation of corn for show purposes, and to the scoring and judging of corn. Business men, farmers, school teachers, members of corn clubs, and others interested in the study of corn are constantly applying for help along these lines.

With a view to giving some information and outlines that will serve as a guide to those interested, this circular has been prepared.

LOCAL CORN SHOWS

Local corn shows have come to be a powerful factor in the movement for better corn. They are instrumental in directing the attention of corn growers to the requirements of good corn. They stimulate friendly rivalry and at the same time stimulate a desire for information. They not only encourage the selection of ears which conform to the score card, but they also encourage the farmer to study cultural methods.

The value and good of the corn show does not end with the improvement of the ear and yield of corn. It is doing much to bring the business man and farmer closer together and to unify their interests. It is tending to turn the attention of all the people to agriculture, which will mean much to the advancement of this industry of the State.

CLASSIFICATION

Corn shows have been held by individual business men or firms, farmers' institutes, county agricultural societies, corn clubs or groups of farmers. Premiums have been offered for the smallest ear of corn, the largest load of corn and for samples of all sizes between these extremes. No general, uniform classification has been adhered to, with the result that judges could not do the most satisfactory work and exhibitors have not always been benefited.

A satisfactory plan in corn exhibits is to enter the corn under some general classification, as white corn, yellow corn, and mixed corn. In some instances it might be desirable to offer premiums for particular varieties of corn, but at this time it does not seem advisable to make such classes in local shows. However, in the future, whenever standards of perfection and variety score cards are agreed upon, this step in the classification may be taken.

SIZES OF SAMPLES

Ten ears is the standard sized exhibit and should constitute a sample, except when premiums are offered for single ears. This number affords an idea of the trueness to type, and other characteristics of the corn exhibited and of the exhibitor's knowledge of good corn. It also offers a convenient basis for computing the markings on the score card.

OUTLINE FOR PREMIUM LIST

Class A. Best 10 Ears of Yellow Corn

1st Premium..... 2nd Premium..... 3rd Premium.....
4th Premium..... 5th Premium.....

Class B. Best 10 Ears of White Corn

1st Premium..... 2nd Premium..... 3rd Premium.....
4th Premium..... 5th Premium.....

CLASS C. BEST 10 EARS OF MIXED CORN

1st Premium..... 2nd Premium..... 3rd Premium.....
4th Premium..... 5th Premium.....

CLASS D. SWEEPSTAKES FOR THE BEST 10 EARS OF CLASSES A. B. C.

1st Premium..... 2nd Premium..... 3rd Premium.....
4th Premium..... 5th Premium.....

CLASS E. BEST EAR OF CORN. ANY VARIETY

1st Premium..... 2nd Premium..... 3rd Premium.....
4th Premium..... 5th Premium.....

RULES GOVERNING EXHIBITS

1. All exhibits will be classified as either white, yellow, or mixed and each must be entered in its proper class. The mixed class will include all exhibits not coming under yellow or white.

2. No exhibitor can make more than one entry in any one class.

3. All exhibits must consist of 10 ears each, except in single ear class.

4. Every exhibit must have been produced on the exhibitor's own farm during the season immediately preceding the exhibition.

5. Entries must be made and the exhibits installed not later than.....(the date and time specified by the committee) and care must be taken to label each sample with the number of the exhibitor and the class in which it is entered.

6. All exhibits remain the property of the exhibitor.

7. All exhibits shall be judged according to the standards and score card of the Indiana Corn Growers' Association.

8. For the purpose of determining shape, size, and vitality of kernels of an ear, two kernels side by side may be removed from the middle portion of ears.

9. Competition is open to township, county, or state, as the exhibit committee may determine.

10. The committee in charge of the exhibit reserves the right to make such other rules as may be found necessary.

ARRANGEMENT AND LOCATION OF EXHIBITS

A large, well lighted room is necessary for a corn exhibit. Light is all important in judging and examining the samples, while plenty of room is desirable, so that the exhibits may be inspected with ease by spectators. Always remember that the good that comes from the show lies in the inspiration and information given to those who study the exhibits as they lie in the show room.



Fig. 1. A well lighted and well arranged show room

Place the exhibits on tables or benches high enough to be examined easily. Give each exhibit sufficient room so that it may be laid out. Samples should never be piled on top of one another. The different classes of corn should be kept separate so as to facilitate the work of the judges and aid visitors in comparing the different samples.

Where shows are held in connection with farmers' institutes or other meetings, the corn should be located in a room separate from the hall in which the meetings are held. The show room should be closed to visitors while the meetings are in session.

PREMIUMS

The matter of premiums deserves serious consideration. Many shows have accomplished but very little for the reason that the premiums were not of the right character and were not properly distributed among the exhibitors. While the offering of but a few

premiums of considerable value may bring out a large number of exhibits and may look well in the announcements, yet it is better to offer a large number of premiums of moderate value. In this way a large number of exhibitors receive premiums, which means that their interest in the work will be increased and their support for future shows secured.

DISPOSITION OF EXHIBITS

In recent corn shows much dissatisfaction has come through the fact that those who conduct the show or donate the premiums, claim the corn exhibited. The average corn grower who breeds up a good strain of corn, and spends his time in selecting from his entire lot of seed the best 10 ears, cannot afford to give this corn for any premium offered at the average corn show. In the second place, corn shows are held with corn improvement in view, and no action can be taken by organizations or individuals that hold corn shows that will mean more in the line of direct corn improvement than to encourage exhibitors to take their corn home, plant it and continue to improve it by selection. This point should receive the serious consideration of all committees in charge of a corn show.

GROOMING OF EXHIBITS

In preparing an exhibit for a show, it is allowable and perfectly proper for the exhibitor to groom the ears so they will present the best possible appearance. All pieces of husks, silks, and the shanks should be carefully removed.

It is not allowable, however, to mutilate the ear in any way. Ears with the protruding tip removed are given the full cut on the assumption that the tip was very poor or it would not have been cut off. Mixed kernels should never be removed and substituted with kernels of the proper color. Expert judges can usually detect these changes and a full cut for color on that ear should be made. The risk of being discovered is too great to warrant any tampering with the ears to be exhibited.

SHIPPING OF EXHIBITS

Exhibits of corn should never be shipped or sent to any exhibition in a basket or bag as there is always great danger of damage in careless handling. Ears injured by breaking or having kernels knocked off through careless methods of shipping, have caused many a good sample of corn to be turned down by the judge. The judge is governed by a strict rule on missing kernels and he cannot be

asked to allow for accidents other than in exceptional cases. Danger of injury can be avoided by carefully wrapping each ear in paper or other protection and packing firmly in a shipping box.



Fig. 2. A common but undesirable way of transporting show corn



Fig. 3. Another undesirable package

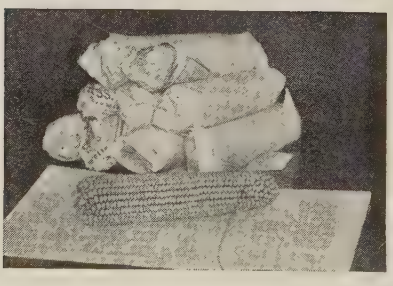


Fig. 4. Ears properly wrapped for shipment

GENERAL PRINCIPLES TO BE OBSERVED IN SELECTING EXHIBITS

The holding of corn shows has a definite purpose; an ultimate object is to be attained, and that object is to improve the yield and quality of the corn produced on our farms. Without such an object there would be no adequate justification for the immense amount of energy, time and money that is being expended annually upon the holding of corn shows all over this country, from the small local shows to the larger state shows and the magnificent national exhibition that is attracting attention throughout the civilized world. More and better corn per acre is the all important object of all this corn show activity and its benefits are being shared by all observing and progressive farmers.

That corn improvement is closely associated with, and in a large measure dependent upon the character of the seed ears selected for planting, is now recognized beyond the shadow of a doubt. Many experts have labored diligently for years to determine what types of ears and kernels will give the best results under proper cultural conditions, and their findings have been expressed in the various corn score cards that are now employed in judging at corn shows, and according to which the best exhibitors are selecting their exhibits.

THE BEST SEED CORN IS THE BEST SHOW CORN

In attacking the problem of corn selection it must be clearly understood that the best sample of corn for show purposes is also the best sample for use as seed, and that every competent corn judge will place his awards upon the samples of corn that, if used for seed, will give the best results. Bearing this in mind, we must consider not only the superficial points of the ears selected, which make for fine outward appearance, but also those qualities of maturity, size of ear, quality of grain, purity, proportion of corn to cob and germinating vigor, that indicate adaptability to the farm conditions where the corn is produced.

As a matter of course, the first thing for the ambitious exhibitor to do is to learn what is wanted and to recognize a good ear of corn when he sees it. *Learning what is good corn and the essential points and details of a good exhibit is by far the most difficult part of selecting prize winning corn.* Serious study must be given to the subject and the requirements of the score card must be understood in every detail and firmly fixed in mind, before any large degree of success can be expected.

METHODS OF SELECTING EXHIBITS

The only sure way to get the best corn available is to make a preliminary selection of all the good looking ears that can be found. This may be done either by going through the fields as soon as the corn is mature, or at the time of the general husking, when every fine looking ear can be put into a special compartment of the wagon box.

After all the good ears have been gathered, the lot should be gone over carefully and a number of the very best, equal to several times the number actually required, laid aside for the critical application of the score card and final selection of the exhibit desired.

About the best plan to follow if a ten-ear exhibit is desired, for example, is to pick out 40 or 50 of the best ears and lay them out on a well lighted table and make a careful single ear score of them.



Fig. 5. Making the final selection of an exhibit

This is best done by taking up one point of the score card at a time and marking down the relative value of each ear on that point. The best ear with reference to the point in question should first be given what is considered its proper value, then the others can be given their proper *relative* values. The second point on the score card should then be taken up in like manner for all ears, and so on through the list of points. After this scoring, one-half to two-thirds can be discarded. The rest should now be matched up for uniformity, giving preference to the 10 ears that are nearest alike in size and shape of ear, size and shape of kernel, indentation, color, etc. Any single ear that would mar the uniformity of the exhibit should be left out, even though it may score high when considered alone. Uniformity with the general type of the exhibit is highly important.

THE CORN SCORE CARD

The following corn score card and explanations of points and rules for judging are those employed by the Indiana Corn Growers' Association and all Indiana exhibitors should be governed thereby.

Before the score card can be intelligently applied it must be clearly understood that its purpose is merely to serve as a systematic guide to the judge or student in corn judging. Its use enables the judge or student to properly weigh and balance the various points of the ear or exhibit in the effort to arrive at a just conclusion as to which is the best sample of corn.

Nothing but patient practice and the exercise of sound sense will enable one to use the score card correctly.

In studying the score card, free use should be made of the illustrations presented on subsequent pages of this circular.

CORN SCORE CARD

of the

INDIANA CORN GROWERS' ASSOCIATION

Name of Variety..... Table No.....

Name of Scorer..... Sample No.....

		1	2	3	4	5	6	7	8	9	
1. Uniformity of exhibit	10										
2. Shape of Ears	10										
3. Length of Ears	10										
4. Color of Grain and Cob	10										
5. Tips of Ears	5										
6. Butts of Ears	5										
7. Kernel— a Shape	10										
b Indentation	5										
c Uniformity	10										
8. Seed Condition	15										
9. Proportion of Grain to Cob	10										
Total - - -	100										

REMARKS AND REASONS FOR CUTS

HOW TO USE THE SCORE CARD

In the rules for judging and the notes explaining the points of the score card, it will be observed that where definite rules for marking are given they are based on an exhibit of 10 ears. The score card may, however, be used also for scoring a single ear exhibit or for making an individual ear score of a ten-ear exhibit. It is provided with 10 vertical columns so that an individual ear score of a ten-ear exhibit may be made on a single card.

In scoring a ten-ear exhibit the scorer should consider the 10 ears as a unit and make one score for the whole 10 ears on each point in one vertical column, making cuts or deductions from the perfect score according to the degree of imperfection.

In scoring a single ear exhibit the whole score should be applied to the single ear and cuts on each point gauged according to the degree of imperfection, as in the case of the ten-ear exhibit.

In making an individual ear score of a ten-ear exhibit, each ear should be considered as a unit and marked independently on each point, applying the whole score, and making cuts, as in other cases, according to the degree of imperfection. In this kind of scoring it is best to judge and score all the ears in the sample on any one point before passing to the next.

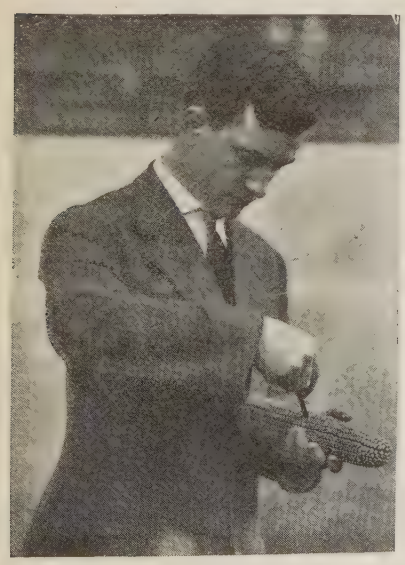


Fig. 6. The wrong way to remove kernels from an ear



Fig. 7. The right way

RULES FOR CORN JUDGING AND EXPLANATION OF POINTS OF SCORE CARD[1]

Note A. Cuts—Where the number of points to be cut is not specified, the scorer must use his best judgment and cut each off ear according to its degree of variance from the standard and the value of the perfect ear.

Note B. Disqualifications—A white cob in yellow corn or a red cob in white corn shall disqualify the exhibit. One or more dead ears shall disqualify the exhibit. One or more ears having 12 or more crossed kernels shall disqualify the exhibit.

Note C. Size of Exhibits—Each exhibit shall consist of 10 ears.

Note D. In selecting show ears, exhibitors may remove two kernels side by side in the same row at between three and four inches from the butt of the ear.

1. *Uniformity of Exhibit.* 10 *Points*—All the ears in the exhibit should be similar in size, shape, color, indentation, size and shape of kernel, and other characteristics.

2. *Shape of Ears.* 10 *Points*—In variety classes the shape of the ear should conform to the variety standard. In general classes the shape of the ear should be cylindrical or nearly so; it should be full and strong in the middle portion, and the circumference should be approximately three-quarters of the length. The rows of kernels should be straight and not less than 16 or more than 22 in number.

3. *Length of Ears.* 10 *Points*—In variety classes the length should conform to the variety standard. In general classes the length should be 8½ inches in Section 1; 9½ inches in Section 2; and 10 inches in Sections 3, 4 and 5 (see page 15); for deficiencies in length, cut at the rate of one point for each inch.

4. *Color of Grain and Cob.* 10 *Points*—The color of the grain should be true to variety, even in shade, and free from mixture. White corn should have white cobs and yellow corn, red cobs. For each mixed or crossed kernel on an ear a cut of two-tenths of a point should be made. Varying shades of color in grain or cob should be cut according to the degree of variance from the standard.

5. *Tips of Ears.* 5 *Points*—The form of the tip should be regular and not too tapering. It should be well covered with straight rows of regular kernels, of uniform size and shape. Proportion of tip covered must be considered, but irregular, shallow or small kernels may be more objectionable than uncovered tips. Cut one-

[1]All specific rules for scoring are based on ten-ear exhibits.

half point for each tip exposed one inch. For irregularities and lesser exposures cut from one-tenth to one-half point according to judgment.

6. *Butts of Ears.* 5 *Points*—The rows of kernels should extend in regular order over the end of the cob, leaving a depression when the shank is removed. Open, swelled, expanded, flattened and pinched butts are objectionable. Cut from one-tenth to one-half point according to judgment.

7. *Kernel.* (*a*) *Shape,* 10 *Points*—In variety classes the shape of the kernel should conform to the variety standard. In general classes the shape of the kernel should conform to the "General Standard of Perfection for Indiana." The tips of the kernels should be full and strong, leaving no space between them near the cob. Towards the crowns the edges of the kernels should be so shaped as to leave merely enough space between the rows to facilitate drying. Shrunken or pointed tips and badly rounded crowns should be heavily cut.

(*b*) *Indentation.* 5 *Points*—The crowns of the kernels should be rather deeply dented but not pinched or chaffy. The dent should extend evenly across the kernel and there should be no sharp or pointed margins.

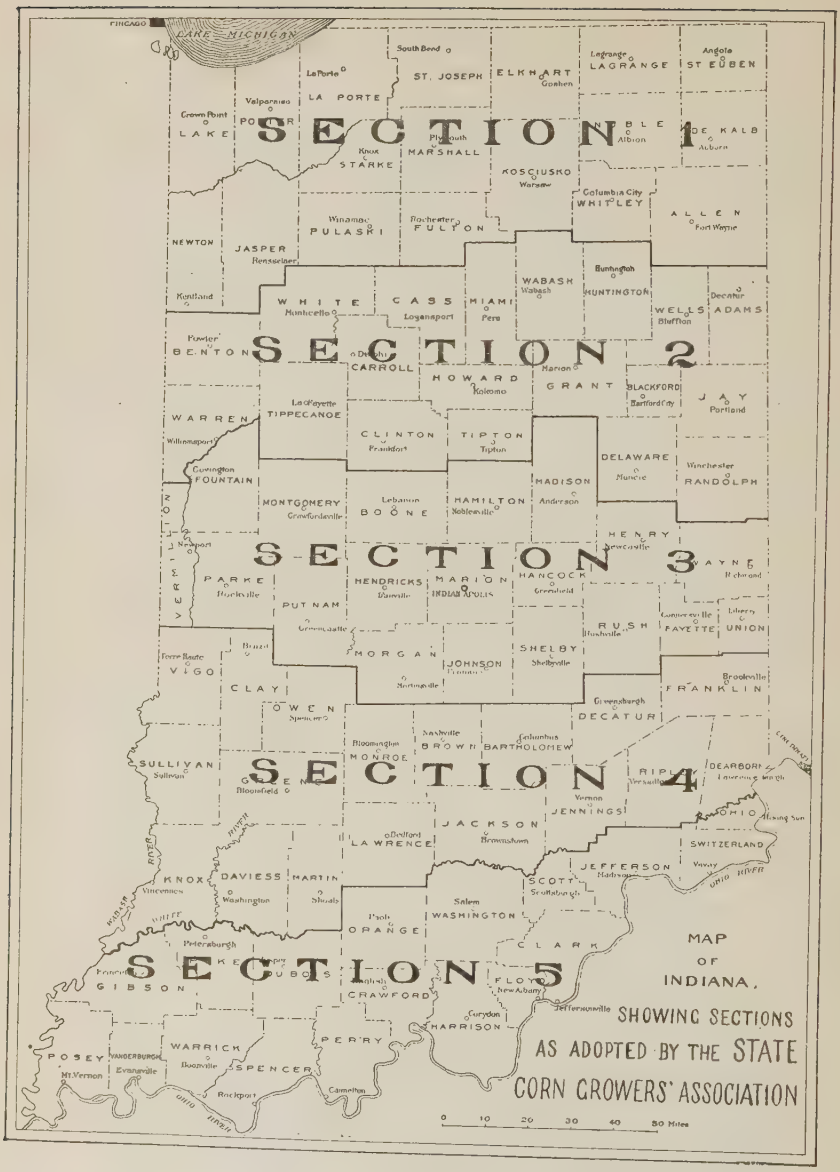
(*c*) *Uniformity.* 10 *Points*—Whatever the character of the kernel, it should be uniform for each ear and throughout the exhibit.

8. *Seed Condition.* 15 *Points*—The ears should be well matured, firm and sound. The germ should be uninjured, large, bright, fresh and vigorous looking.

9. *Proportion of Grain to Cob.* 10 *Points*—In variety classes the proportion of grain to cob should conform to the variety standard. In general classes it should be not less than 86 per cent. For each per cent. below standard, cut the exhibit two points.

GENERAL STANDARD OF PERFECTION FOR INDIANA

A perfect ear of corn should be cylindrical or nearly so in shape. The circumference of the ear should be about three-fourths of its length. The rows should be straight and not less than 16 or more than 22 in number. The kernels should be well formed, (above five-sixteenths of an inch wide by five-eighths of an inch long), uniform in size and shape, and six to the inch in the row.


CHICAGO
LAKE MICHIGAN
SECTION 1
SECTION 2
SECTION 3
SECTION 4
SECTION 5
LAKE
PORTER
LA PORTE
ST. JOSEPH
ELKHART
LAGRANGE
STEUBEN
DE KALB
NOBLE
STARKE
MARSHALL
KOSCIUSKO
WHITLEY
ALLEN
NEWTON
JASPER
PULASKI
FULTON
WABASH
HUNTINGTON
WELLS
ADAMS
WHITE
CASS
MIAMI
BENTON
CARROLL
HOWARD
GRANT
BLACKFORD
JAY
WARREN
TIPPECANOE
CLINTON
TIPTON
DELAWARE
RANDOLPH
FOUNTAIN
MONTGOMERY
BOONE
HAMILTON
MADISON
HENRY
PARKE
HENDRICKS
MARION
HANCOCK
WAYNE
PUTNAM
RUSH
FAYETTE
UNION
MORGAN
JOHNSON
SHELBY
VIGO
CLAY
FRANKLIN
OWEN
DECATUR
SULLIVAN
MONROE
BROWN
BARTHOLOMEW
DEARBORN
RIPLEY
JENNINGS
OHIO
JACKSON
SWITZERLAND
LAWRENCE
JEFFERSON
KNOX
DAVIESS
MARTIN
SCOTT
WASHINGTON
ORANGE
CLARK
GIBSON
CRAWFORD
FLOYD
HARRISON
PERRY
POSEY
VANDERBURGH
WARRICK
SPENCER
MAP
OF
INDIANA,
SHOWING SECTIONS
AS ADOPTED BY THE STATE
CORN GROWERS' ASSOCIATION
0 10 20 30 40 50 Miles

INDIANA SECTIONS BY COUNTIES

For regular corn shows held under the auspices of the Indiana Corn Growers' Association the State has been divided into sections by counties as follows:

Section 1. Standard length, 8½ inches. *Counties*—Lake, Newton, Jasper, Porter, LaPorte, Starke, Pulaski, Fulton, Marshall, St. Joseph, Elkhart, Kosciusko, Whitley, Noble, LaGrange, Dekalb, Allen, Steuben.

Section 2. Standard length, 9½ inches. *Counties*—Benton, Warren, Tippecanoe, White, Cass, Carroll, Clinton, Tipton, Howard, Miami, Wabash, Grant, Delaware, Blackford, Huntington, Wells, Adams, Jay, Randolph.

Section 3. Standard length, 10 inches. *Counties*—Fountain, Vermillion, Parke, Putnam, Montgomery, Boone, Hendricks, Morgan, Johnson, Marion, Hamilton, Madison, Hancock, Shelby, Rush, Henry, Wayne, Fayette, Union.

Section 4. Standard length, 10 inches. *Counties*—Vigo, Owen, Clay, Sullivan, Knox, Daviess, Greene, Martin, Lawrence, Monroe, Brown, Jackson, Bartholomew, Jennings, Ripley, Decatur, Franklin, Dearborn.

Section 5. Standard length, 10 inches. *Counties*—Gibson, Posey, Vanderburg, Warrick, Pike, Dubois, Spencer, Perry, Crawford, Orange, Washington, Harrison, Floyd, Clark, Scott, Jefferson, Switzerland, Ohio.

ILLUSTRATIONS

The following illustrations are intended to show the various strong and weak points of ears of corn. They should be carefully studied in connection with the points of the score card and will be found very helpful in arriving at a proper understanding of what the score card calls for and what is considered good corn.

Figures 8 and 9 illustrate the point of uniformity. Fig. 8 represents an exhibit of a high degree of uniformity. All the ears are remarkably similar in all essential type characteristics.

Figure 9 represents an exhibit that is quite ununiform in almost all the prominent characteristics, including size, shape, shape and size of kernels, indentation, etc., and it would be hard to determine what particular type it is supposed to represent.

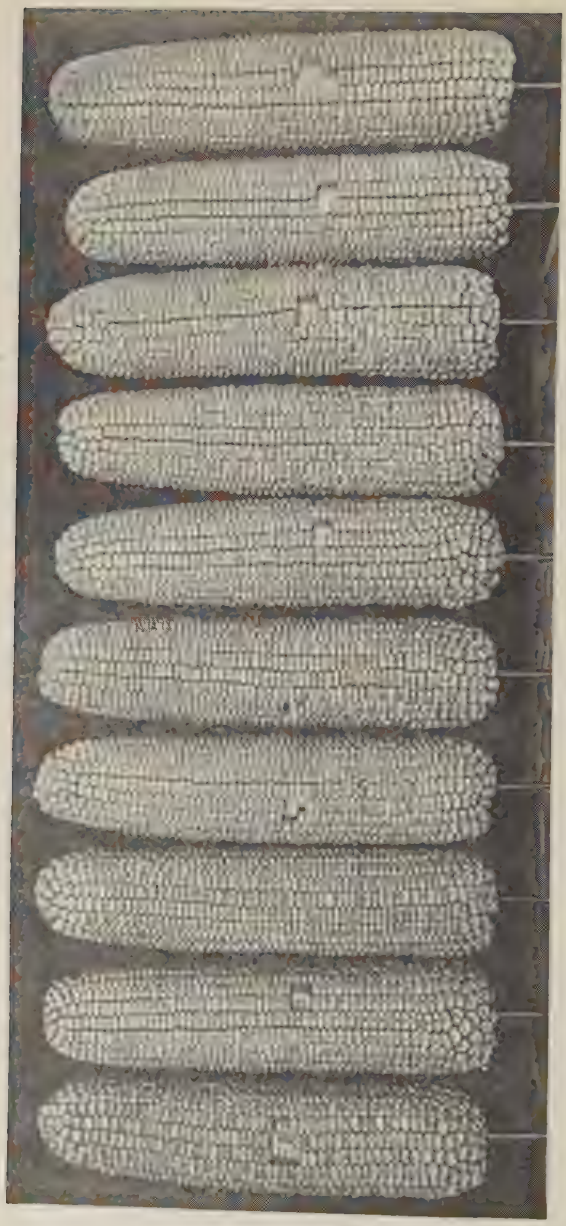


Fig. 8. A uniform exhibit of high quality



Fig. 9. An ununiform exhibit

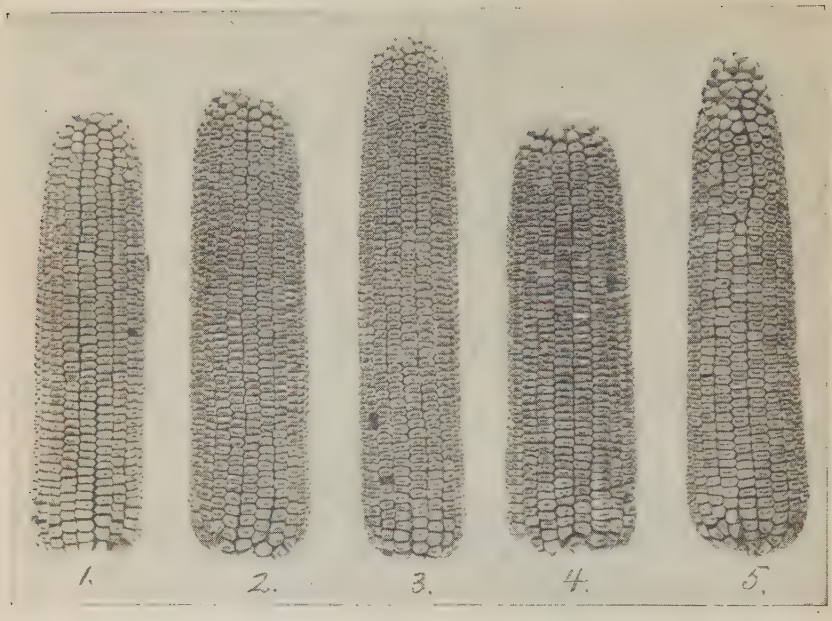


Fig. 10. Different shapes of ears

Figure 10 illustrates a number of distinct types as to shape of ear.

No. 1 is a well formed ear of good proportions.

No. 2 is a little too thick for its length and is slightly constricted near the butt end.

No. 3 is too small in circumference in proportion to its length.

No. 4 is much too thick for its length.

No. 5 is too tapering.



Fig. 11



Fig. 12

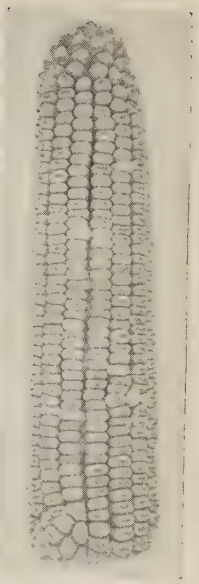


Fig. 13

Color of corn and cob

Figure 11 represents a yellow ear with a white cob. Yellow corn should have red cobs.

Figure 12 represents a white ear with a red cob. White corn should have white cobs, except where the red cob is a variety characteristic, and in such a case all the cobs should be red.

Figure 13 represents a yellow ear with some white or "mixed" kernels, indicating fertilization with pollen from white corn. Yellow corn should not show any of their "white caps" and white corn should not show yellowish kernels, as both are marks of impurity.



Fig. 14. Good and poor tips

Figure 14 represents a variety of good and poor tips of ears.

Numbers 1, 2, 3 and 4 are all good tips, No. 4 being particularly fine although not completely capped over.

Numbers 5, 6, 7 and 8 are all poor tips. The kernels on No. 5 are small and shallow and very irregular, while No. 8 is much too pointed.

The tip of a good ear of corn should be as well filled with deep, regular sized kernels as possible. Uniformity with the rest of the ear in size, shape and depth of kernel is more important than complete covering of the tip.

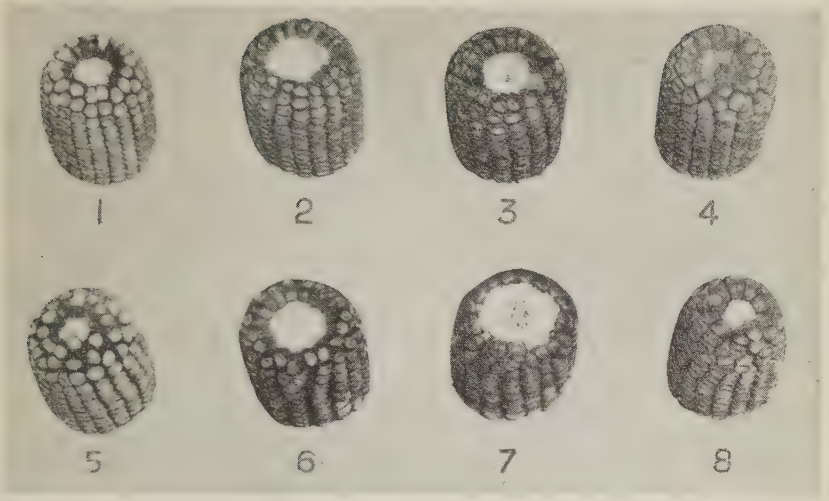


Fig. 15. Good and poor butts

Figure 15 represents a variety of good and poor butts of ears.

Numbers 1, 2, 3 and 4 are all good butts. No. 1 is particularly uniform but the kernels are a little too thick. In No. 2 the kernels are more regular. No. 4 is well rounded and deep but shows some irregular kernels, which is the only objectionable feature.

Numbers 5, 6, 7 and 8 are all poor butts. No. 5 is too pinched and has too small a shank. No. 6 is too open and irregular. No. 7 is flat and shallow, has irregular and compressed kernels, and the shank is much too large and coarse. No. 8 is much too compressed and pointed, besides being quite shallow and having too small a shank.

The character of the butt is especially important as an indicator of good breeding.



Fig. 16. Various types of kernels

Figure 16 illustrates the point of kernel shape.

Numbers 2 and 12 are excellent pairs of kernels. No. 3 is a strong pair of kernels but they are a little too short. No. 5 is fair but rather weak at the tip, as is also No. 8. No. 6 is a well formed pair but delicate. Numbers 1, 4 and 9 are much too short. No. 11 is coarse and rather short. No. 10 is rather long, much too pointed and inclined to be chaffy.

A good kernel must be full and strong at the tip, giving room for a large germ which is essential to strong vitality and high feeding value. The edges should be nearly straight, but they must converge towards the tip sufficiently to allow the rows to fit fairly closely together. Uniform thickness from crown to tip is also important.



Fig. 17. Furrows between rows

In Fig. 17 kernel shape is further illustrated by good and bad spacing of the kernels at the crowns.

Numbers 1 and 5 show good spacing and the kernels are of good size and shape.

In Nos. 2 and 4 the furrows are too wide, No. 4 showing quite rounded crowns, indicating a small proportion of corn to cob. The kernels are also quite shallow.

In ear No. 3 the rows are too much crowded, preventing proper air circulation for drying, and the kernels are also too small. The spacing at the crowns may be too close, especially in large ears, making them dry too slowly and liable to mould.

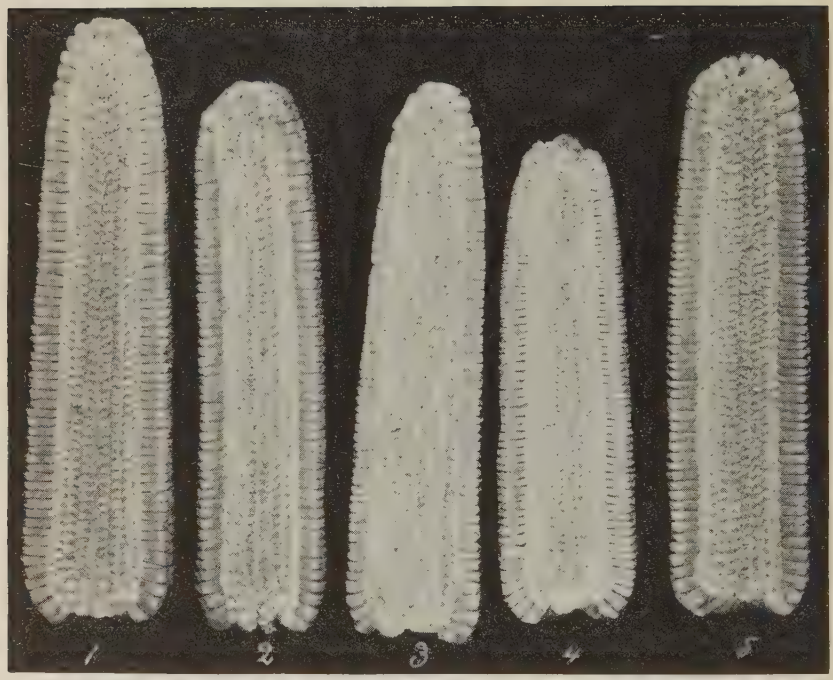


Fig. 18. Good and bad spacing of kernels at the cob

Figure 18 illustrates the point of kernel shape by good and bad spacing of the kernels at the cob.

Ears Nos. 1 and 4 show wide spacing between the kernels at the cob, No. 4 being particularly bad. The tips of the kernels are very much shrunken. Such space is very objectionable as it means poor vitality and low feeding value.

Ears Nos. 2 and 3 are fairly perfect, the kernels fitting closely together from tip to crown. Ear No. 5 is also fair but shows quite a number of small spaces at the cob.

The tip end of the kernel should be strong and full and as thick as the crown. The kernels should fit closely together at the cob. Wide spaces are often found and always indicate shrunken or pointed tips.

The tip of the kernel is probably the most important characteristic to observe in considering the points of kernel shape.

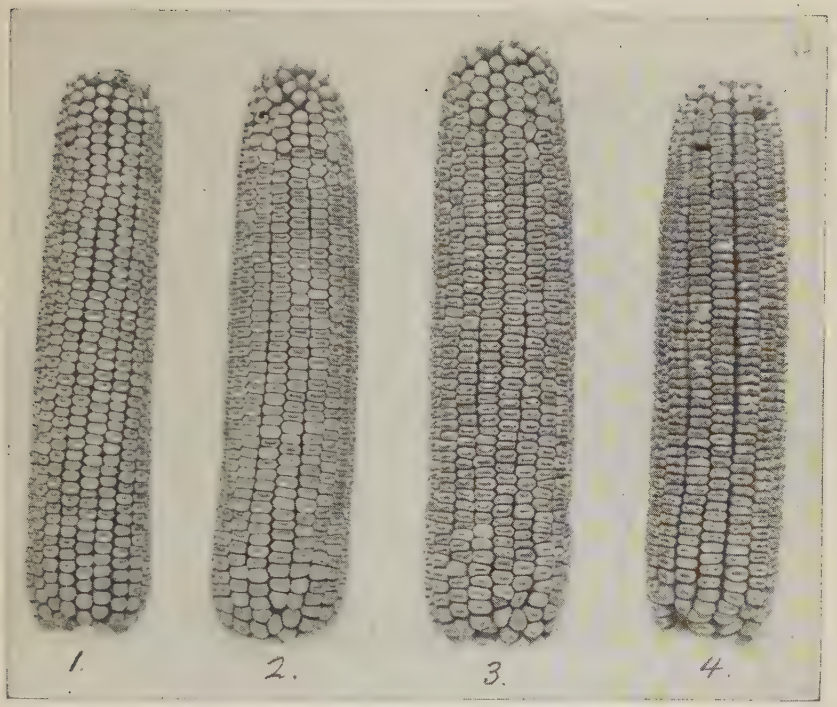


Fig. 19. Kernel indentation

Figure 19 illustrates the point of kernel indentation.

Ear No. 3 is for the most part well dented. Ear No. 4 is a little too rough in the middle portion. Ears Nos. 1 and 2 are much too smooth. Smooth kernels are nearly always shallow.

A properly dented kernel shows an even crease of medium depth extending squarely across the kernel and without sharp or pointed margins.

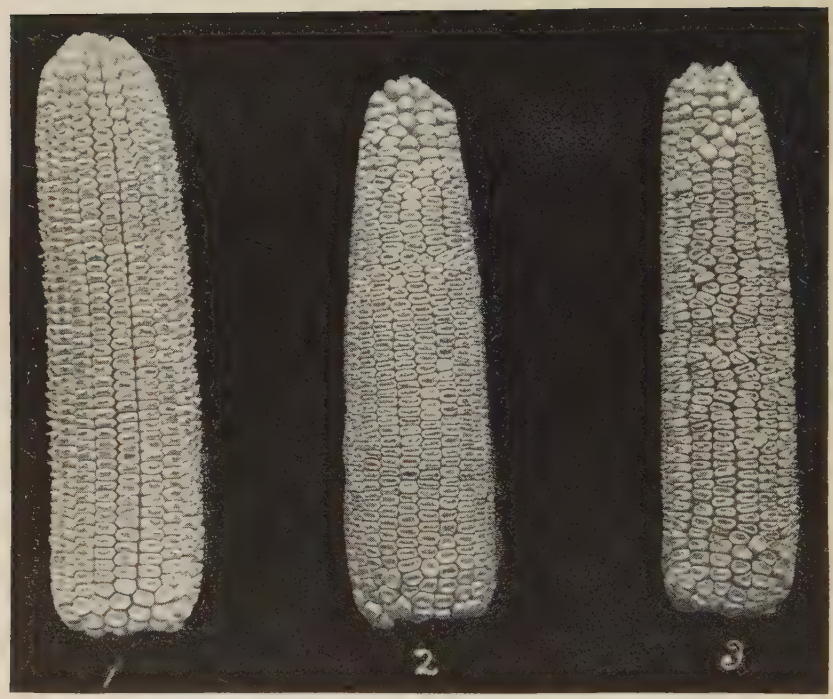


Fig. 20. Kernel uniformity

Figure 20 illustrates the point of kernel uniformity within the ear.

In ear No. 1 the kernels are quite uniform in size and shape throughout the ear. In ear No. 2 the kernels vary considerably in size and shape and there are some dropped and broken rows which have caused a lot of ununiform kernels besides making a tapering ear.

Ear No. 3 shows a lot of odd shaped kernels that could not possibly run evenly through a planter.

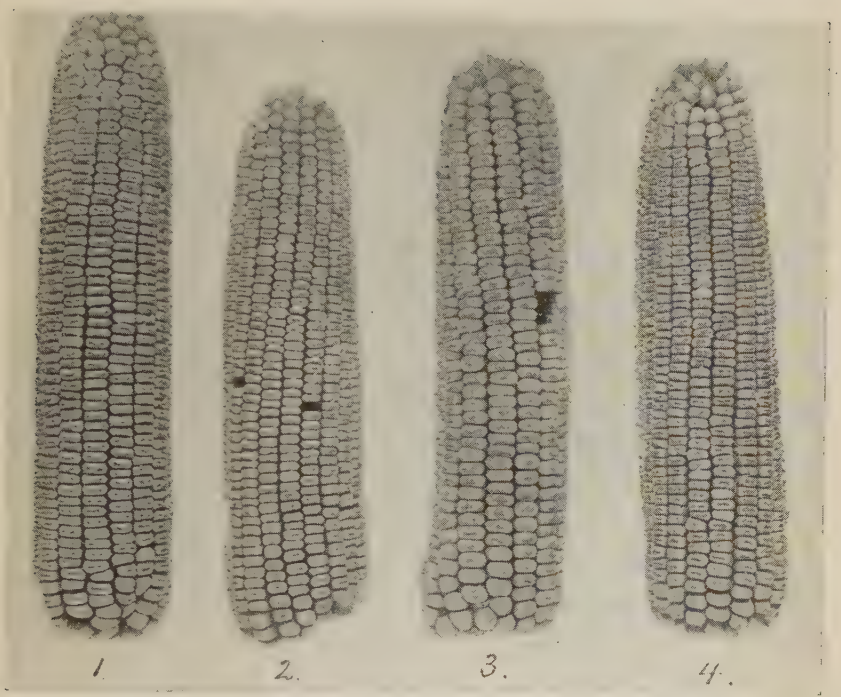


Fig. 21. Ears with different sized kernels

Figure 21 illustrates the point of kernel uniformity when applied to an exhibit as a whole. Within each ear the kernels are quite uniform but no two ears are alike.

Ears Nos. 1 and 4 would come nearest to going together and both have good types of kernels, although No. 1 is perhaps a little too broad.

On ear No. 2 the kernels are too small to match either of the other ears.

On ear No. 3 the kernels are too large and coarse and quite different from anything else in the exhibit.

Every ear should have uniform kernels within itself and all the ears in an exhibit should be alike. There is an important reason for this, and it is that no corn planter can evenly plant a lot of different sized kernels at the same time. (See Fig. 8)



Fig. 22. Immature and damaged kernels

Figure 22 illustrates the point of seed condition with special reference to the maturity of the kernel.

No. 4 is a sound, well developed pair of kernels. Pair No. 1 shows blisters on the front and back. Pair No. 2 shows shrunken tips and adhering bits of chaff. Pair No. 3 shows broken tips and "black caps" or exposed germs. Pair No. 5 shows light colored, starchy, immature spots on the front and back. Pair No. 6 shows broken kernels more or less decayed.

A mature kernel should have a clean tip, uniform color on front and back, smooth, full germ and a fresh, glossy appearance.



Fig. 23
Mouse eaten kernels

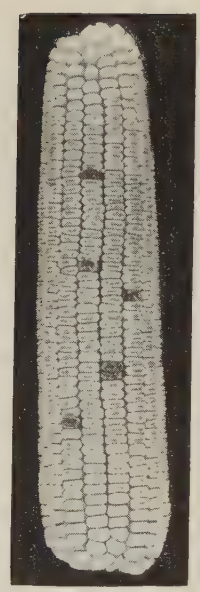


Fig. 24
Decayed kernels

Figures 23 and 24 further illustrate the points of seed condition.

Figure 23 shows an ear that has been damaged by mice. The crowns of the kernels have been gnawed off.

Figure 24 shows a number of decayed and mouldy kernels.

A well matured ear should have a rigid cob with firm, broad kernels throughout.

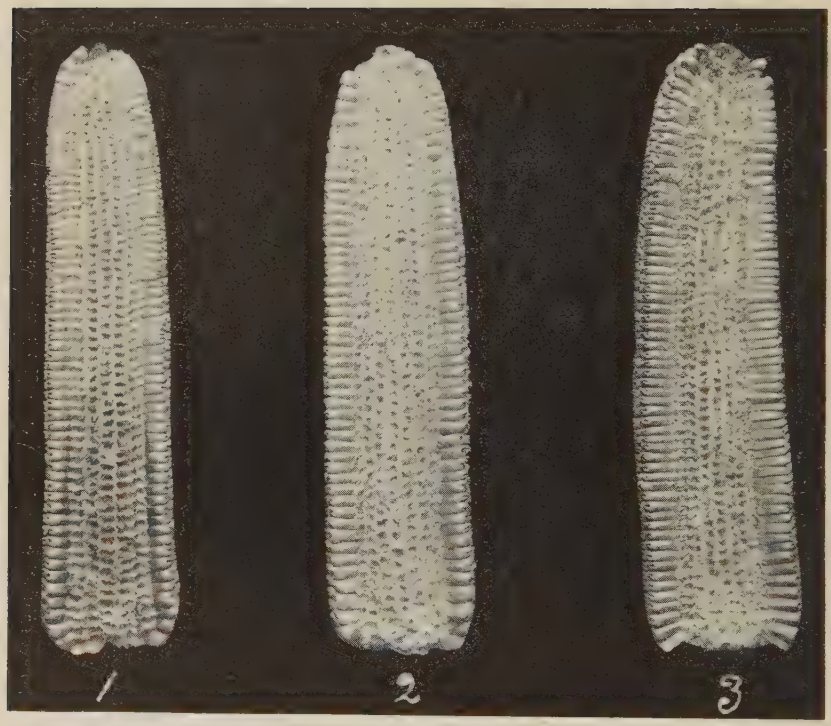


Fig. 25. Proportion of corn to cob

Figure 25 illustrates the point of proportion of corn to cob.

Ear No. 3 has very deep kernels and a relatively small cob, showing a large proportion of corn to cob.

Ear No. 2 has a large cob with rather shallow kernels.

Ear No. 1 has quite shallow kernels, showing a small proportion of grain to cob.

EXAMINING THE CORN KERNEL FOR FEEDING VALUE

The feeding value of a grain of corn depends upon the amount of protein (flesh producing material) and fat it contains. The germ is rich in protein and contains nearly all the oil in the kernel. The hard, horny matter contains most of the protein, while the white, floury portion contains relatively little of either protein or fat. Bearing this in mind, the relative feeding value of two ears of corn can be roughly determined by an examination of the kernels. The larger the germ and the greater the proportion of hard, horny matter to white, floury matter, the higher the feeding value. It has been found that the ears of any variety vary considerably in composition but that the kernels on each ear are of approximately the same composition. It is therefore comparatively easy to select the ears of highest feeding value.

Figure 26 shows, in the upper row, kernels from ears of high feeding value. Observe the large germs. The second row shows kernels from ears of the same varieties which are low in feeding value. The longitudinal and cross sections of kernels show very clearly how widely the proportions of germ, hard, horny and white, floury portions may vary.

When you are selecting seed corn, select for their general qualities several times the number of ears you intend to use and then go over them carefully for their feeding value. The larger the number of ears from which selection can be made, the better. Examine several kernels from each ear by cutting them crosswise through the middle, as shown in Fig. 26. The relative proportions of germ, horny and floury portions can thus be easily seen. By selecting the richer ears for seed, year after year, the feeding value of corn can be considerably increased.

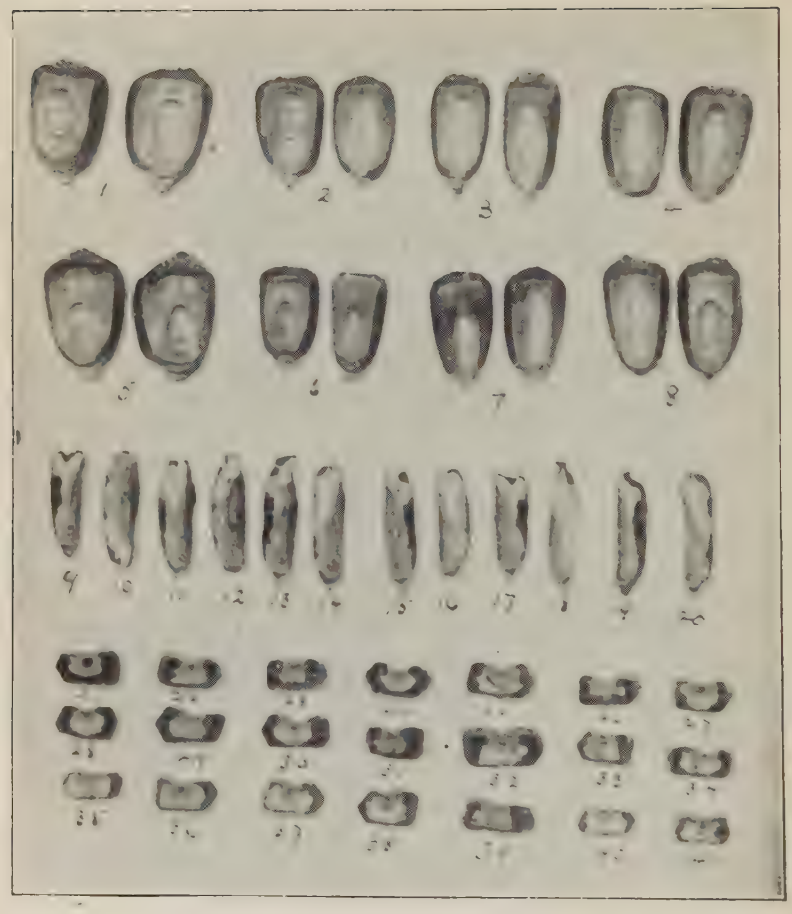


Fig. 26. Variations in the feeding value of corn

In Figure 26 are illustrated some of the wide variations that exist in the kernels from different ears of corn. Each pair of kernels in the upper two rows is from a different ear. Pairs Nos. 1 to 4 show large germs. Pairs Nos. 5 to 8 show small germs.

The cross and longitudinal sections show differences in the proportion of germ, hard, horny matter and white, floury matter in kernels from different ears.

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 19

LaFayette, Ind., November, 1909

AGRICULTURAL EXTENSION
III

INDUSTRIAL CONTESTS FOR BOYS AND GIRLS

G. I. Christie Henrietta W. Calvin

The Industrial Contest for Young People is beyond the experimental stage in Indiana. More than 45 counties have organized boys' and girls' clubs and have conducted corn growing, bread baking, and butter making contests. Thousands of boys and girls have been interested and actively engaged in this experiment which is working directly for the betterment of agriculture and the home.

The contest is popular and has been strongly supported because it offers a medium through which the cause of agriculture can be furthered. It brings the people into close and active relationship with the things that are immediately about them. It encourages study, opens new avenues of thought, widens the horizon and brings about a realization of the importance and magnitude of the interests of country life. It creates a respect for industry and labor and tends to elevate work from the plane of drudgery to one of pleasure.

Young People's Clubs and Contests have been organized and conducted by various individuals and organizations and in various ways. Most of the efforts have been successful—a few have resulted in failure. The work was new, there were no outlines to follow and people did the best they knew. However, as a result of these trials there has come about a plan of organization for the work, which is believed by those actively engaged in the movement, to be the best under present conditions. It is given here, not with the idea



County Corn Club boys judging corn at Purdue Farmers' Short Course

that clubs and contests already successfully organized should change or that it is the only workable one, but, as a plan that has proved highly satisfactory and one which counties organizing for the first time may have for their consideration.

ORGANIZATION

In organizing clubs and contests it is necessary to consider factors that will bring about the desired results and at the same time give permanency to the organization. That is, the club or contest should be affiliated with some recognized organization that perpetuates itself from year to year.

From a study of Indiana conditions it is believed that the County Farmers' Institute in cooperation with the County Superintendent of Schools and his forces meets all the requirements for the organization and conducting of clubs and contests.

The Farmers' Institute is a thoroughly organized agricultural body and has for its chief object the betterment of conditions of the agricultural people. This organization also has authority by a recent act of the State Legislature, to engage in this line of work and to use a portion of its funds for premiums for agricultural contests.

The County Superintendent of Schools should be enlisted in this movement and should give it his hearty support, since the clubs and contests assist him in training better boys and girls. They bring the teachers and pupils closer together and are of great value in rallying the parents to the support of the schools. He is necessary in the organization, for by his office he is in direct touch with the boys and girls. Through his teachers he is able to enlist the pupils in the club and contest work. Also, through his office, a large amount of executive work can be done and thus relieve the Institute people of this burden. By him, cooperation of the teachers who are necessary to the success of the work, can be secured.

Among these forces, work can be divided in a way that it can be made more effective and helpful from every standpoint than if one individual or organization attempted to carry out all the many details.

STEPS IN ORGANIZATION

According to the Institute Law of 1907, work for the coming year must be authorized by members at a meeting during the present year to secure county funds for meeting expenses. For this reason the club and contest work should receive support by the Institute

Body at the Annual Meeting. The Chairman should be authorized to appoint a committee to organize and execute the work.

The committee should be as follows:

Chairman of County Farmers' Institute.
Secretary of County Farmers' Institute.
County Superintendent of Schools.
President of Women's Auxilliary.
Secretary of Women's Auxilliary.
One other interested man.
One other interested woman.

In appointing members of the committee, the Chairman should be careful to select only those who are interested and who are willing to give it their active assistance.

This committee should come together at the earliest date possible after appointment to decide upon the lines of work to be followed and to arrange for the carrying out of the plans. Any delays in deciding these matters result in a loss in the effectiveness of the work.

After the lines of work have been adopted, steps should be taken to enlist the boys and girls of the county. This can best be done through the County Superintendent of Schools. A letter to the teachers explaining the objects of the contests and why the boys and girls should join, and asking the teacher in turn to explain this to the pupils, usually results in placing the matter before the boys and girls in a satisfactory way.

Suggested form of letter to be sent to school teachers of the county:

Dear Teacher:

An effort is being made in this county to organize Industrial Contests for boys and girls of the schools. The enclosed outlines will give you some idea of the work contemplated.

Through these contests it will be possible to interest the boys and girls in the work of the farm and the home and at the same time create greater interest in the school work. For this reason, we ask you to cooperate in this movement and assist us in interesting the boys and girls together with their parents in these contests.

Kindly explain the purpose of the contest to your pupils and have all those who will agree to undertake the work, sign the attached pledge which should be returned to this office at once.

Thanking you for your interest and cooperation, I am

Very truly yours,

County Superintendent.

Pledge:

We, the undersigned, agree to join the..... County Boys and Girls' Club and to take an active part in the contests to be conducted this year.

Name	Township	Age
.....		
.....		
.....		
.....		
.....		
.....		
.....		



Boys and Girls' Club, Hamilton County, Indiana

MASS MEETING

At sometime about the first of April a meeting of all those interested in the contest should be held at some central point. The object and details of the contest should be presented and full instructions given for carrying on the work.

Some popular speaker should also be present to arouse interest and enthusiasm for the work. In this way all are started with a clear understanding of what is expected of them and the interest in the work will be greater.

CORN GROWING CONTESTS

Requirements for Entry

1. All contestants shall be between 10 and 18 years of age.
2. Each contestant shall agree to make a special study of scoring, selecting, planting, cultivating, and harvesting corn.
3. Each contestant shall grow a plot of corn each year. (Size of plot to be determined by club.)
4. Each contestant shall plant, cultivate and gather his or her own corn.
5. Each contestant shall keep, according to an outline adopted by the club, a record of the details concerning the plot, work done, and number of bushels harvested.
6. Each contestant shall write an essay of not over four hundred words on corn growing.
7. Each contestant shall select a sample of ten ears grown on the plot and exhibit them at the annual corn show of the club.
8. Each member shall take an active part in the meetings of the club when requested and shall do everything that will make the club a success.

Contestant's Record Blank

A detailed record should be kept of the plot, dates of planting, cultivating, harvesting, etc., and the crop.

Record of Corn Plot

(To be filled out by each contestant.)

1. Contestant's name
 P. O. Address.....Rural Route.....
2. Variety of corn planted.....
3. Source of seed.....
4. Method of handling seed from time of gathering the previous fall to planting time.....
5. Vitality of seed:
 How tested
 Per cent. of germination.....
6. Plot:
 Length in feet.....Width in feet.....
 Area in sq. ft..... Kind of soil.....
 Kind of subsoil.....

7. History of plot:
 Crops grown there for three years previous to time of planting. 1907..... 1908..... 1909.....
8. Fertilizers applied during three years previous to time of planting. 1907 1908 1909
 Kind
 Amount
9. Fertilizers used in 1910:
 Kind
 Amount
10. Preparation of seed bed:
 Date of plowing.....
 Cultivation

Implements	Time used
.....	
.....	
.....	
.....	

11. Date of planting.....
12. Name of planter used.....
13. Distance between rows.....
14. Distance between stalks in rows if drilled....
15. Number of kernels per hill planted.....
16. Cultivation:

Number	Date	Depth	Reason
1.			
2.			
3.			
4.			

17. Kind of cultivator used.....

Harvest Time

18. Number of stalks in plot:
 Barren
 Smutted
 Suckered
 Two-eared
19. Stand of corn in plot:
 Average number of stalks per hill.....
20. Date the corn matures:
 Roasting ear.....
 Dented or glazed.....
 Ripe

21. Height of corn (measure 10 average plants and take the average) feet.....inches.

22. Total number of leaves on 10 plants each taken from different hills

23. Yield:
 Bushels on plot.....
 Bushels per acre.....

24. Cost of producing corn:
 Value labor of boy at 12c. per hr.
 Value team and boy at 25c. per hr.
 Cost of plowing.....hrs. @ per hr.
 Cost of preparing seed bed....hrs. @ per hr.
 Cost of manure or fertilizer
 Cost of seed
 Cost of planting.....hrs. @ per hr.
 Cost of cultivation:
 Harrowing hrs. @ per hr.
 1st cultivation hrs. @ per hr.
 2nd cultivation hrs. @ per hr.
 3rd cultivation hrs. @ per hr.
 4th cultivation hrs. @ per hr.
 Hoeing hrs. @ per hr.
 Other cultivation hrs. @ per hr.
 Cost of husking corn hrs. @ per hr.
 Cost of harvesting fodder....hrs. @ per hr.
 Rental value of land for corn
 Total cost

 Yield of plot.....bushels
 Cost of producing one bushel of corn
 Cost of producing one acre of corn

Small booklets for the keeping of records can be secured of the Secretary, Indiana Corn Growers' Association, LaFayette, Ind.

CONTESTS FOR GIRLS

It has been deemed advisable to so arrange the contests for girls that their work might cover somewhat the same length of time as that of the boys. These contests might well be in breads, canned fruits, and sewing of various kinds.

The work should be so arranged that small girls shall not be forced to compete with those much older. Girls from 10 to 14 years should be placed in one class and those of 15 to 18 years in a second class.

BREAD CONTEST

Girls 10 to 14 years

1. Each contestant shall agree to bake at least twenty-five individual loaves of bread between the first of May and the first of November.
2. Each contestant shall agree to exhibit two loaves of bread at the annual show.
3. Each contestant shall do all the work without any outside help.
4. Each contestant shall keep a record of the details concerning the work done.
5. Each contestant shall write an essay, of not over four hundred words, giving record of number of loaves baked in summer, kinds of flour used, sources and kinds of yeast, the manner of baking, cooling, and the storing of bread, and the length of time required for each process in bread making.
6. Each contestant shall agree to write a second essay, of not over four hundred words, on the history of bread; bread as made in other countries; what yeast is and how it grows; the manufacture of flour; the difference between hard and soft wheat flour; the quality of a loaf of bread as affected by the wheat and the flour entering into its composition.

Girls 15 to 18 years

The contest for girls 15 to 18 years should be along similar lines to that of the first class except that they should agree to bake fifty loaves of bread between the first of May and the first of November and to prepare a more extensive paper on subjects in 5 and 6.

Note.—These papers should be presented with the bread when entered for prizes.

CANNED FRUIT CONTEST*

1. Each contestant shall agree to can at least ten varieties of fruits or vegetables.
2. Each contestant shall agree to exhibit at least ten one-pint jars of fruit or vegetables, properly labeled, with date, name of fruit and manner of preservation upon the label.
3. Each contestant shall agree to do all the work without any outside help.
4. Each contestant shall present a paper of not over four hundred words, telling how the fruit or vegetable was gathered, cared for, canned and stored.

*Classes as to age should be arranged as in premium bread contest.

5. Each contestant shall prepare a second paper of not more than four hundred words, giving reasons why foods are preserved; methods of food preservation and the reasons for food fermentation and decay.

SEWING CONTEST

Girls 10 to 14 years

1. Each girl shall agree to either darn and exhibit one pair of stockings, patch one piece of wool material and one piece of plaid cotton material and exhibit same, or make by hand one plain gingham apron and exhibit same. Any one girl may bring all these varieties of work.
2. Each contestant shall agree to do all the work herself without help.
3. Each contestant shall write an essay of not more than four hundred words explaining the stitches used in the work and methods of doing same.
4. Each contestant shall write a paper on the growth of cotton and the processes involved in making it into white cloth.

SEWING CONTEST

Girls 15 to 18 years

1. Each contestant shall agree to make and exhibit either one shirt waist or one fancy white apron or both of these articles. Machine work, hand sewing and buttonhole making must all be exhibited on these pieces.
2. Each contestant shall agree to do all of the work herself without outside help.
3. Each contestant shall agree to write an essay of not more than four hundred words explaining all the processes employed by her in the production of the article.
4. Each contestant shall agree to write a second paper concerning the history, use and care of a sewing machine and explaining the dyeing and printing of cotton fabrics.

CLUB MEETINGS

Meetings of clubs at stated intervals, under the personal supervision of school teachers, will maintain interest, train more thoroughly for the contests, make the work more truly educational and supplement the regular work of the school. The meetings may be held in the township high school or in some other central school house.

SHOW

The show where the products of the contests may be exhibited should be held at some central and accessible point in the county. A large suitable room should be provided and arrangements made to classify all entries. That is, the corn from each township should be grouped and a special place provided for bread and other articles. This will facilitate the judging and increase the educational value of the exhibit.

The show should be held as soon after corn harvest as is convenient. Shows held during late winter result in a loss of exhibits and of interest among the contestants. It is important to bring every exhibit and contestant into the show in the best possible condition and spirits. This means much in the results attained.

PREMIUMS

The matter of premiums is one of great importance. While the object of the contests is to create interest and educate directly, yet the young people look forward to winning a premium. For this reason provision must be made for a large number of premiums.

In the past there has been a general tendency to offer a few premiums of high value, but it is found that the offering of a large number of premiums though they be small, will do much to maintain interest and enthusiasm for future work.

It is also agreed that the more educational these premiums can be made, the better it is for the members of the club. A trip to the Farmers' Short Course at Purdue University; a trip to the State Fair, or some other educational course or trip, with all expenses paid, means more to the recipient than would a cash premium. As a premium, it appears larger than the amount of cash required to finance the trip and creates greater interest in the work. The contestant is directly benefited as a result of the premium and at the same time goes back into the community and schools and is an inspiration to the other young people.

For the smaller premiums, suitable books and subscriptions to magazines or agricultural papers may be given.

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 20

LaFayette, Ind., December, 1909

AGRICULTURAL EXTENSION

IV

MILK PRODUCTION

III

ECONOMIC AND SANITARY MILK PRODUCTION

O. F. Hunziker O. E. Reed

SELECTION OF THE DAIRY COW

In the selection of the dairy cow lies the foundation of profitable milk production. The dairyman may be a careful and intelligent feeder and he may be skillful in the handling of the product; but if the cows in his herd are inferior and low producers, he cannot hope to derive profits from his business.

There are two methods which can be used in the selection of cows for the dairy. The first method is selection by conformation or type of the cow; the second method is selection of cows from known records of their individual production.

SELECTION BY CONFORMATION OR TYPE

In order to select dairy cows by their appearance to the eye, the dairyman must know the dairy form and conformation. The

typical dairy cow is a very angular or wedge-shaped animal. The organs of her body which go to produce milk have been abnormally developed. This has been done largely at the expense of the development of other portions of the body, chiefly those that are essential in beef production. The wedge-shape form is the natural result of this. A good dairy cow has a deep and wide chest, denoting a good constitution.

She has a large paunch or barrel, especially deep just in front of the udder, and well sprung ribs, a strong jaw and a large muzzle; these characteristics indicate large capacity for digesting and assimilating food; a large, well shaped udder, extending well forward along the belly and upward between the thighs. The size of the udder should be secured by length and width, as an udder of this shape is less liable to injury than a pendulous one. The function of the udder is that of secreting and holding milk. Large capacity of the udder, therefore, indicates large milk flow. It should be as free as possible from fleshiness.

She has large mammary veins. This is important, as these veins indicate the amount of blood that passes through the udder. Their size is determined by the size of the milk wells. The mammary veins are not as large and crooked in young cows as they are in older animals. This should be considered in selecting young animals.

She has a loose-jointed spinal ~~cord~~ column with open spaces between the vertebrae or sections of the backbone, and the ribs are wide apart. These characteristics indicate plenty of nervous force which is necessary, since large milk production seems to be closely associated with abundant nervous force. The nervous force has its beginning in the brain of the cow and passes along the spinal cord. The nerves branch off from the spinal cord between the vertebrae and connect with the nervous organs of the body; the larger the nerves, the more open the vertebrae and the farther apart the ribs. A prominent, bright eye is also an indication of nervous development.

The pelvic region is well developed, making plenty of room for the maternal organs. The loin is broad and strong, the hips and thighs wide apart and the rump long and roomy.

Other points which are generally considered in describing the dairy type are: a thin neck, fine bone and hair, sharp withers, dished face, and so on. These are all common with the best dairy cows and are generally found with animals that possess the other characteristics mentioned.



Fig. 1. A typical dairy cow

SELECTION BY TEST

While the type or form of the cow is an indication of her value as a dairy animal, this should not be taken as final proof of her ability as an economical producer. After the cows are brought into a herd, a record of the actual production of each cow should be kept. Such records can be used to distinguish between the profitable and the unprofitable animals in the herd. To dispose of the latter and to raise the heifer calves from the best cows is sure to increase the productiveness and profits of the herd.

MILK RECORDS

Where the milk is sold by weight or measure regardless of the fat content, the producer is interested in knowing the milk yield of the individual. If the milk is sold on the butterfat basis, a record of both milk and per cent. of fat should be known. An excuse that is often given for not keeping records is that it involves a great amount of labor. This is a mistake. When things are properly arranged and managed, the making and keeping of records requires but very little time. With a milk sheet properly ruled, bearing the names or numbers of the animals in the herd and the dates of the days in the month, and a small spring balance conveniently located in the stable where the milking is done, the milk from each cow can be readily recorded.

DAILY MILK RECORD FOR MONTH OF DECEMBER

Name of Cow

DATE																															
1	A. M.																														
	P. M.																														
2	A. M.																														
	P. M.																														
3	A. M.																														
	P. M.																														
4	A. M.																														
	P. M.																														
5	A. M.																														
	P. M.																														
6	A. M.																														
	P. M.																														
7	A. M.																														
	P. M.																														
8	A. M.																														
	P. M.																														

It is best to weigh the milk of each cow at each milking and to keep a daily record of it. A definite knowledge of each cow's milk production from day to day furnishes a basis on which intelligent feeding can be done. It makes possible more economic feeding.

Daily records also enable the dairyman to detect sickness in his herd more quickly than might otherwise be the case. Any abnormal condition of the animal tends to affect the milk flow. In the case of a decline in the milk flow from one day to another, the cause of the same can be investigated at once. Some simple treatment applied before the ailment has made much headway may remedy it and forestall a more serious case of sickness and possibly the loss of the animal.

BUTTER FAT RECORDS

When the producer is selling milk or cream on the butterfat basis and wants a record of the fat production, the following method may be used: weigh the milk from each cow for three consecutive days during the middle of each month and take a composite or average sample for the same length of time. This composite sample is used to determine the per cent. of fat in the milk. It is made up by measuring an uniform, small amount of milk from each milking in a sample bottle. Use a one-half pint Mason fruit jar or similar bottle. For measuring use a pipette or small dipper. Pour the samples from each of the six milkings into the same bottle. Keep the bottles tightly stoppered. A bottle for each cow should be provided for this purpose. This bottle should be labeled with the name or number of the cow whose milk it contains. The per cent. of fat is found by testing this sample with the Babcock test. This test is very simple and directions for making it are furnished with the testing outfit when purchased. A complete outfit sufficient for a small herd can be purchased for $5.00.

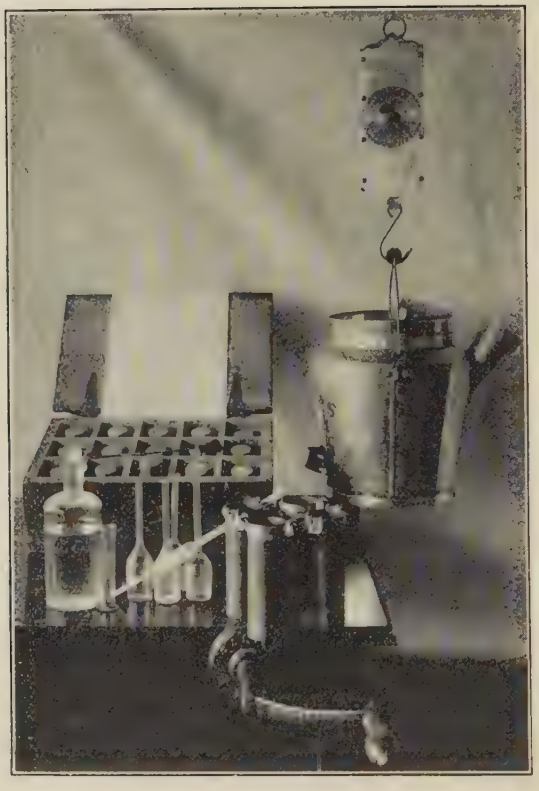


Fig. 2. Milk scales and testing outfit

When a composite sample of milk is saved for a fat test for a period of several days some preservative must be used to prevent the souring of the sample. A few drops of formalin, which may be secured from the druggist, added to each sample bottle is best to use for this purpose.

The average weight of milk produced per day is found from the weights taken for the three days. This amount multiplied by the per cent. of fat contained in the composite sample will give the average daily production of butterfat. This daily average of milk and butterfat is multiplied by the number of days in the month. This gives the weight of milk and butterfat produced by each cow for that month. Where the milk record is kept for the entire month, a three days' composite sample can be saved and the aver-

age of fat for the month obtained in the same way as mentioned above. Multiply this average by the actual production of milk for the month; this figure is more accurate than the one obtained by the previous method.

These records are made every month and the total of the results of 12 consecutive months yield the annual record of milk and butterfat produced by each cow. If, in addition to this, the dairyman keeps a record of the amount and cost of the feed fed to each cow, it is a simple matter to determine the profits made by each cow and to spot the unprofitable cows—the boarders.

SELECTION OF THE DAIRY SIRE

The selection of the sire is a very important factor in building up a dairy herd. It is generally conceded that the herd bull is one-half of the herd, and in reality he is more than that. The daughters of a scrub bull almost invariably show a decrease in production as compared with their dams.

The selection of a desirable dairy sire is a great deal more difficult than that of the dairy cow. Here, too, type and conformation are important factors for consideration, but they do not necessarily preclude that the sire is capable of building up the herd. It is highly



Fig. 3. Gorgeous Boy 67767: Jersey herd bull, Purdue Experiment Station. The merits of this bull are shown by the increased production of his daughters over their dams

essential that his dam has a high record of production. The better his ancestry, the better a bull will he chance to be. In the case of a young bull, conformation and record of his ancestry are the only indications to his fitness to head the herd. In the case of an older bull his own performance is the best indication of his actual merits. If his daughters show creditable records of production, there can be little doubt as to his ability to improve and increase the productiveness of the herd.

In the selection of the herd bull, neither time nor money should be spared. The best is the cheapest.

FEEDING THE DAIRY HERD

In order to reap the highest economic returns from a properly selected and bred herd, the animals must be fed intelligently.

Economic feeding resolves itself into a study and execution of the lesson which nature teaches. The greatest production of milk is obtained in May and June, or early summer. At this time the cow is doing her best. The ration the cow receives at this time is nature's ration, grass in its choicest form. There is plenty of food at hand, it is palatable and easily digested and the cow is comfortable. The intelligent feeder, therefore, will strive to maintain these conditions as nearly as possible throughout the year.

As the season advances the pastures dry up or get short and should be supplemented. This may be done by growing some green crop to be fed at this time. The corn plant is the best adapted for this purpose, especially through the corn belt, as it grows rank and the yield per acre is large. Other crops may be grown for this purpose, such as oats and peas sown together, and sorghum. Green alfalfa may be fed, if it is at hand. Where it is not possible to feed some such green crop, the pastures should at least be supplemented with hay of some kind. If some supplement is not used to keep up the milk flow, the cow will fall off in the milk and it will be very difficult to bring her back to her milk during that milking period.

As winter approaches the conditions prevailing in early summer must now be provided for by the feeder. The first condition to be looked after is that of furnishing an abundance of palatable food. The supply of feed should be plenteous and the ration should be balanced.

It is highly essential that the farmer know something of the composition of the different feeds and know how to combine these

feeds in a ration to get the best results. There are three groups of substances that must be considered in making up the food for the dairy cow. These substances are contained in almost all feeding stuffs to a greater or less extent. They are protein, carbohydrates and fat.

The protein or the nitrogenous substance is the most expensive one of the three. It is used by the animal in the production of hair, hoof, horn, milk, blood and muscle. Such foods as alfalfa, cowpea and clover hays, cotton-seed meal, linseed meal, bran, oats and gluten feeds contain a high per cent. of this substance.

The carbohydrates and fat may be classed together. They are used by the animal to produce heat to keep the body warm, to furnish energy, to carry on the life functions and to make the fat that is stored up in the body and in the milk. Such feeds as corn, corn silage, timothy hay, corn fodder, millet hay and oat and wheat straw contain a high per cent. of carbohydrates. All of the foods mentioned in both groups contain some fat. The fat is equal in value to two and one-fourth times the value of the carbohydrates and is used for the same purpose.

A balanced ration must contain foods from both groups. The carbohydrates can best be had by using corn as the grain ration. Corn is especially well adapted to furnish this material, since it is a staple grain product and contains a high per cent. of carbohydrates. The protein can be obtained more cheaply in the form of roughage, since the grain feeds containing a high per cent. of the protein are expensive and usually have to be purchased. By feeding such hay as clover, cowpea or alfalfa the protein can be furnished at less expense and can be produced on the farm. A ration consisting of cowpea, alfalfa or clover hay for roughage, and corn as the grain, gives good results. For a high producing cow, however, such a ration does not contain enough protein and should be supplemented with some of the grain feeds containing a high per cent. of protein, as bran, oil meal, oats or gluten feed. A very common mistake that is often made, is to feed timothy hay for roughage and corn alone for the grain. It is next to impossible for a cow to produce the maximum amount of milk on such a ration.

To feed cows economically they must be fed as individuals and not as a herd. It is often the case that cows in a herd are all fed the same amount, regardless of the amount of milk produced. By such a practice some cows will be overfed, while others are underfed.

In feeding animals it should be understood that the animal uses a certain amount of the food it receives to maintain the body.

This is called the food maintenance and it is the first use to which the animal puts its food, whether producing milk or not. The feed given in excess of this amount is used for producing milk, storing fat on the body, or for growth in the case of the young animal.

Of the two mistakes in feeding, perhaps underfeeding is the most common. It is a poor practice and a serious mistake to feed a cow only that amount required to maintain her body and deprive her of sufficient additional feed to produce all the milk she is capable of producing. The effect of underfeeding may not be noticed at once, as a cow will produce milk for a time at the expense of her body, that is, she will take the surplus flesh off her body and convert it into milk. Hence, if a cow declines in weight while producing milk, it shows that she is not receiving enough feed.

In the case of a cow being overfed, it may be detected in a short time by the fact that she will put fat on her body, or she may get off feed.

Another condition of summer feeding, which should be maintained or imitated during the winter is that of feeding a succulent ration. By the term succulent feed is meant feed having that property possessed by green grass. Such a feed has a value outside of the nutrients it furnishes. It serves to keep the digestive organs in good condition, thus aiding digestion. This succulence may be secured in the winter ration by feeding silage or roots. Where roots can be grown successfully they serve the purpose very well. In the corn belt it is found more profitable to use corn silage. The large yield of forage per acre makes the corn plant well adapted for silage. Aside from supplying an excellent feed, the silo furnishes a means of handling the whole corn plant in the most convenient and best way possible.

The main object in formulating a ration after selecting the feeds to be used, is to provide a sufficient bulk at all times to satisfy the appetite and feeding capacity of the animal and to furnish the amount of nutrients needed for the work the cow is doing. If the ration lacks bulk the cow will be discontented. An animal may be fed enough nutrients in the form of grain to perform her work, but if a sufficient quantity of bulk is not given she will not be satisfied. The roughage should form the foundation of the dairy ration. A cow should have all the roughage she can clean up at all times. The grain ration should be regulated by the amount of milk produced. Under these conditions, the rule of feeding one pound of grain for each three pounds of milk produced, works fairly well. A cow producing very rich milk should have a little more than this amount.

AN ECONOMICAL HOME-GROWN RATION

Alfalfa	12 lbs.
Corn silage	30 lbs.
Corn meal	5 lbs.
Ground oats	2 lbs.



Fig. 4. This is a succulent home-grown ration. It contains enough nutrients for a 1000 pound cow producing 30 pounds of 4 per cent. milk per day. This entire ration may be grown on the farm. Where alfalfa cannot be grown, cowpea or clover hay can be substituted

AN EXCELLENT DAIRY RATION

Alfalfa	10 lbs.
Corn silage	30 lbs.
Wheat bran	2 lbs.
Cotton-seed meal	1 lb.
Corn meal	4 lbs.



Fig. 5. This is an excellent dairy ration. It contains enough nutrients for a 1000 pound cow, producing 30 pounds of 4 per cent. milk per day. This ration contains sufficient bulk, is balanced, succulent and palatable

As the winter feeding period comes on the animal's comfort should be considered. Shelter and clean quarters should be provided. A cow will respond readily to warm and comfortable stables, well lighted and properly ventilated. If exposed to cold, a large portion of the feed ration which otherwise would be turned into milk goes to supply the necessary warmth. This makes economic feeding impossible, since the feed of the dairy cow makes expensive fuel.

FEEDING THE CALF ON SKIM-MILK

In many localities a great deal of money is lost each year by feeding calves on whole milk or letting them suck the cow. This is often due to the fact that those who practice such methods do not believe good calves can be raised on skim-milk. They rather picture the skim-milk calf as being a small, unhealthy, stunted individual that is absolutely worthless. Many such cases can be found; however, such results should not be charged up to the skim-milk, but rather to the ignorance or carelessness of the feeder. It has been shown that as good calves can be raised on skim-milk as with whole milk. They may not look so well for the first few months in life, but at the end of one year it is hard to tell a skim-milk calf from one that has run with its mother. The skim-milk calf often makes a better growth in this length of time, as it is better fitted to take care of itself after being weaned. The calf receiving skim-milk learns to eat grain and hay fast and depends more on them for its food.

The feeding of the calf by hand should begin when it is only two or three days old. Some prefer to take the calf away before it is nursed. The longer the calf is let run with its mother, the harder will it be to teach it to drink. If started in time, no special difficulty is experienced in getting it to drink. The usual method is to allow the calf to suck the finger until it will hold its head in the pail and drink without assistance. The milk fed at this time should be fresh milk from the mother and not allowed to cool.

The calf should continue to receive fresh whole milk for a period of two to three weeks. The amount given will vary from eight to 12 pounds or from one to one and one-half gallons per day during this time, the exact amount depending upon the size of the calf. The change from whole to skim-milk should be gradual, taking about a week for the change. Begin reducing the amount of whole milk and adding a little skim-milk, gradually increasing the skim-milk until the calf is receiving skim-milk entirely. By the

time the calf is four months old it should be receiving from 16 to 18 pounds of skim-milk per day.

It is highly important that the skim-milk be fresh and warm. When it is possible, the skim-milk should be fed fresh from the separator. If not, then it should be warmed to a temperature of about 90 to 95 degrees F. before being fed.

If these conditions are not kept uniform, good results cannot be expected. The same amount of milk should be fed each time, for overfeeding will often cause scours or some other sickness.

The grain ration for the calf, while on skim-milk, can be made corn alone. It is best to feed ground corn until the calf learns to eat. After it is well started on grain, shelled corn will give equally as good results and the calf likes it better.



Fig. 6. Skim-milk calves

When the calf is weaned, the grain ration should be changed and more nitrogenous foods given, such as:—bran, oats and oil meal, etc. A ration of corn and oats mixed in the proportion of two parts corn to one part oats makes a good home grown ration. Calves do exceedingly well on this ration, when fed clover, alfalfa or cow-pea hay, in addition to the grain. The amount of grain fed should

be governed by the appetite of the animal. Only that amount should be fed that the calf will clean up nicely.

Feed all the hay the calf can eat at all times. While the calves are very young, timothy hay is, probably, better to feed than alfalfa, clover, or cowpea hay. The latter, when fed to very young calves, often brings on a case of scours. As the calf grows older such hays can be fed with safety and better results will be insured. During the pasture season, the calf on good grass can take care of itself.

THE CARE OF MILK

The care of milk by the producer begins before the milk is drawn and ends only when the milk is delivered to the buyer or his agent. The proper care of milk will furnish the consumer with one of the most wholesome and nutritious articles of human food and it enables the producer to place it in the hands of the consumer fresh and sweet, preventing losses due to spoiling on the farm, in transit or at the consumer's house. The result of improper care is milk that will not keep long enough to reach the consumer sweet and in normal condition, and that may be dangerous to the health and life of the commonwealth.

Healthy Cows.—Good, wholesome milk can come from healthy cows only. If the cow suffers from a disease, she cannot do as well at the pail and the milk may be infected with the germs of disease.

The most common and most dreaded of all cattle diseases is that of tuberculosis. The only sure way to determine whether animals are free from tuberculosis lies in the tuberculin test, properly performed. All reacting animals (those that are found tuberculous by the test) should be separated from the herd and their milk should not be used unless previously pasteurized. All milk from animals suffering from any other contagious disease should be pasteurized before use.

Milk from animals suffering from local affections or which are otherwise in run-down condition may also be unfit for use as food. When the animal is not in good physical condition the body functions are generally not normal. The poisons of the body may not be properly passed out of the body through the natural channels (the excretory organs) and may find their way into the milk.

When cows approach calving time and immediately after calving, their milk is abnormal in its composition, and the properties of the food elements it contains are abnormal. Such milk is not suitable for human food, nor for the manufacture of butter, cheese and other dairy products. Milk from cows 30 days before and

three to seven days after calving should not be sold for consumption or manufacture.



Fig. 7. A good type of inexpensive milk house



Fig. 8. A poor type of milk house

Fermented or Spoiled Milk.—The reason milk sours or spoils is that it contains a large number of germs, called bacteria. These germs are so small that they cannot be seen with the naked eye. If 100 of them were put side by side, the total thickness of the entire row of germs would not be as much as the thickness of a single sheet of writing paper. The dairyman only knows that they are there because of their work; they spoil the milk. They grow better and, therefore, spoil the milk quicker, when the milk is warm. If the milk is cooled to a low temperature soon after it is drawn, it keeps longer because these germs cannot work in it and spoil it so readily.

Source of Bacteria.—Bacteria are found everywhere in nature. It is hard to find any place or substance where we do not also find bacteria. They are present in the air surrounding us, in the water, in the soil, on the skin and hair, and in the upper air passages and intestinal tract of man and beast. They are especially abundant in dust, dirt, manure and filth of all kinds.

If we wish to keep the bacteria out of the milk and have the milk keep sweet for a reasonable length of time, we must keep the dirt out of it. The cleaner the milk, the longer will it keep. This can be done by paying close attention to the suggestions offered in the succeeding paragraphs.

Clean Yards.—If the cows have to wade knee-deep through a filthy yard covered with manure, we cannot expect to keep the milk free from dirt. The teats, udder and flanks become coated with filth, some of which will fall into the pail when the milk is drawn.

The best way to keep the yard clean is to keep it dry. A wet yard may be made dry by grading it so the surface water can be run off. If that will not do, it should be drained with tile drains, or the surface may be covered and tamped with crushed stone, gravel, refuse from tile factories, or cinders. When the yard is once dry it is an easy matter to remove the few droppings that are left there daily.

Clean Stables.—The stable must be so constructed that it can be readily kept clean. The cows should not be compelled to stand on the bare ground where they kick up a lot of dust with their fore feet and splash around in the mud with their hind feet. A properly laid plank floor is better than the bare ground, and a cement floor is better than a wooden floor. The walls and partitions should be plain and offer as little surface as possible for dust and dirt to lodge. The ceiling should be tight, preventing dust and hayseed from sifting down on the cows, and cobwebs from forming. The stalls

should be of such size as to give the cows reasonable freedom of movement and at the same time prevent them from turning sideways, or from standing with their hind feet in the gutter, or far enough forward to deposit their droppings on the stable floor. The size of the stalls should be governed by the size of the cows. For small animals, such as Jerseys and heifers, a stall 36 inches wide and 48 to 54 inches long will afford plenty of room. Large animals, such as Holsteins, require stalls 36 to 40 inches wide and 54 to 60 inches long.

A gutter about six inches deep and 18 inches wide, constructed of cement, and slanting to one end of the stable, best serves to take care of the droppings.

Swing stanchions are the cheapest and all around most satisfactory ties, give the cows sufficient movement for comfort, are easily operated and prevent the animals from stepping too far back or forward.

The mangers should be so constructed that they can be kept clean easily. Cement mangers are more serviceable than wooden mangers; wooden mangers are better than none. If constructed so that they afford a clean sweep either from one end of the manger to the other or from the feeding alley to the gutter, labor is saved in cleaning them.

Bedding.—An adequate supply of clean bedding is necessary for the comfort of the animals and greatly helps to keep them clean. Straw, tanner's bark, sawdust or shavings furnish satisfactory material for bedding.

The manure should be removed at least once a day and far enough from the stable to prevent undesirable odors from polluting the stable atmosphere.

Light.—The direct rays of the sun are the best natural purifiers and disinfectants. Darkness is the natural breeding place for germs of filth and corruption. One window 3 feet by 3 feet for every two cows furnishes the necessary light for a sanitary stable. Windows, to be effective, must be kept clean.

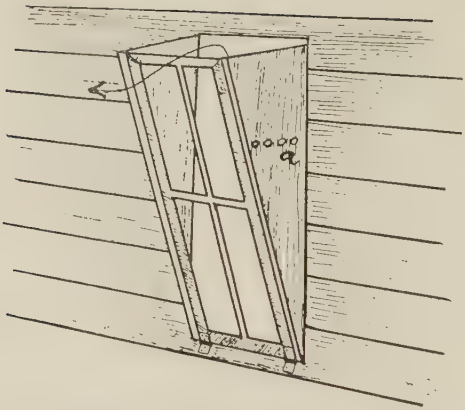


Fig. 9. Hinging the window at the bottom on inside of barn gives the best window ventilation

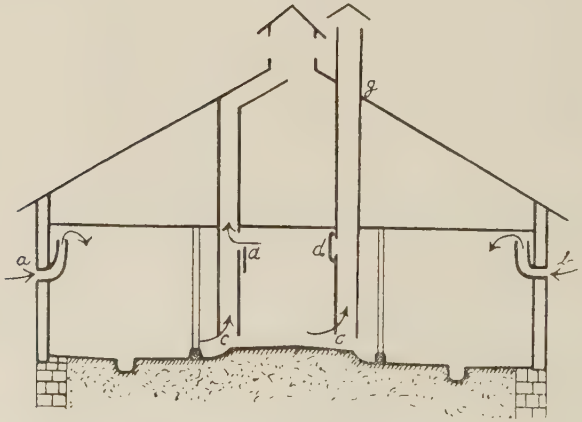


Fig. 10. Showing the King ventilating system in a one story barn. The fresh air enters the barn at a and b. The foul air is taken out at c. Two outlets are represented in the figure, the straight outlet at g gives good results in case the other outlet cannot be used. The opening at d is closed during the winter and opened in warm weather

Air.—Plenty of pure and fresh air is a necessity for the health o fthe cows and the purity of the milk. The King system of ventilation, properly installed, provides for a continuous change of air, without exposing the cows to severe drafts, and permits of retaining comfortable temperature in the stable at all times of the year. The muslin system of ventilation also gives satisfactory ventilation and is especially adapted for barns of cheap construction. Cover one sash of each window with a good quality of muslin and leave sashes covered with muslin, open.

The cleaning and sweeping of the stable should be done several hours before milking time, to allow the dust to settle. The floor should be sprinkled with water before sweeping.

Whitewash.—A good coat of whitewash, once a year, purifies the stable atmosphere and raises the sanitary tone of the stable wonderfully. Slack one-half bushel of unslacked lime with 15 gallons of water, mix thoroughly and put the whitewash or milk of lime on the floor, walls and ceiling with a broom or spray pump. One bushel of lime will whitewash a good size stable and one barrel of lime can be bought for $1.00.

Feed.—Any feed that does not interfere with the health of the animal and does not impair the flavor of the milk is safe to feed to the dairy cow, if fed judiciously.

Rye pasture, rape, garlic, wormwood, chicory, and ragweed give milk a bitter flavor. Musty and moldy hay, sour silage, decayed roots, fermented distillery slops and sour beet pulp impart a bad flavor to the milk. Roots of strong flavor, such as turnips, should be fed immediately before or after milking. They should be given in moderate quantities. Onions and wild onions should be kept out of the dairy ration.

Rich concentrates, such as cotton-seed meal and oil meal should be fed in moderate quantities only. Good corn silage, one of the most economical succulent winter feeds for dairy cows, improves rather than impairs the flavor of milk. Overfeeding of concentrates, or forced feeding, injures the wholesomeness and flavor of milk, because it interferes with the physical condition of the cow.

Water.—A plentiful supply of fresh, pure water is necessary for the production of a large flow of good milk. The dairy cow needs a good deal of water to produce milk, because over four-fifths of the composition of milk is water. She further needs water to keep her system in good working order. Impure water interferes with her health, and therefore injuries the quality of the milk.

The cows should not be compelled in winter to get their water by sticking their noses through the ice in the creek or pond. They

cannot drink all the water they need when they receive ice water. A watering trough in the yard or stable, to which the cows have access several times daily is practical and efficient. In winter the trough should be supplied with a stove to warm the water. Automatic water buckets attached to the manger are not sanitary and can, therefore, not be recommended.

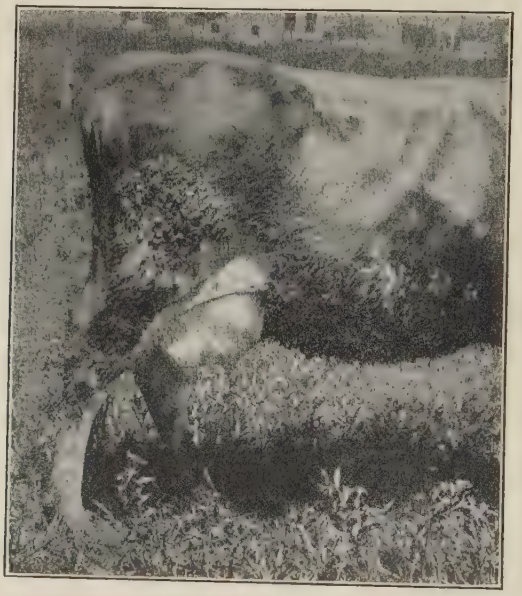


Fig. 11. Dirty flanks. The greatest source of dirt found in milk during the winter

Clean Cows.—The most simple means of having clean cows is to prevent them from getting besmeared with filth. This can be accomplished by proper attention to clean stables and stalls as described. Immediately before milking, their udders and flanks should be wiped off with a clean, damp cloth.

Clean Milker.—The milker should wash his hands before milking and draw the milk with dry hands. Milking with wet hands is a filthy practice, unbecoming a man.

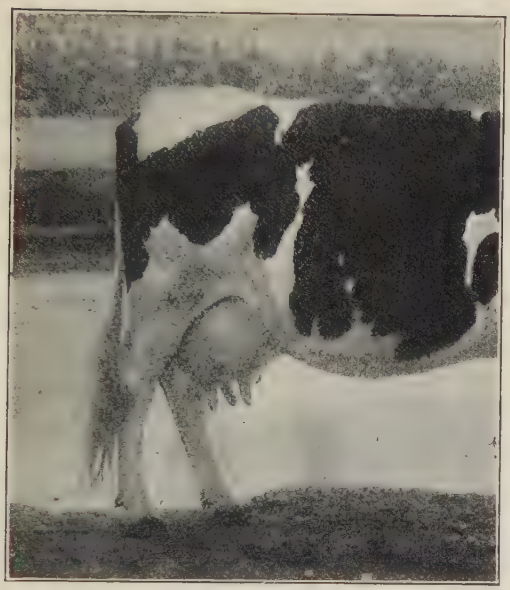


Fig. 12. Keep the flanks clean. It requires but little time and the milking will be more pleasant

Clean Utensils.—The pails, cans and other utensils constructed of metal should be heavily tinned and the seams flushed with solder. Rusty and badly dented cans and pails are breeders of filth and can be kept clean with difficulty. All utensils that come in contact with milk, such as pails, cans and dippers, strainers, coolers and bottles, must be kept clean and sweet. Rinse them with cold water as soon as possible after use, wash them clean with brush and hot water containing some good washing powder, rinse and scald them with boiling hot water, and allow them to drain and dry in a clean room or on a suitable rack outdoors where they are not exposed to dirt or dust. Milking pails should have a reasonably small opening, not more than six inches in diameter, to prevent unnecessary contamination of the milk with dust and hair from the animal's body during milking.

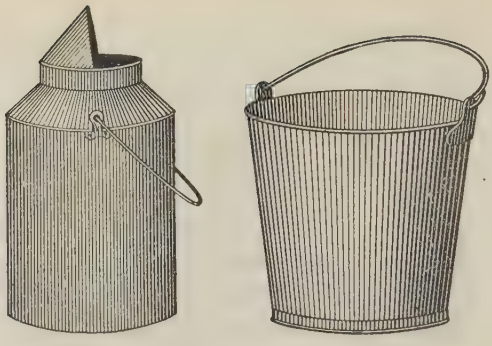


Fig. 13. Types of milk pails. The pail with small opening is the better



1 2

Fig. 14. Milk cans in the condition represented in Fig. 1 cannot be kept clean and should be discarded

Straining.—Remove the milk from the stable immediately after it is drawn, to a separate and clean room or house reserved for the handling of milk only. Strain it through a clean cloth or wire mesh strainer. A wire mesh strainer is preferable, as it can be kept clean more easily. If a cloth strainer is used, it should be thoroughly rinsed with cold water and boiled for at least 20 minutes after each use.

Cooling.—If the milk is to reach the consumer in sweet condition, it must be cooled immediately after it is drawn. If it is not cooled the germs it contains will cause it to sour rapidly and become unfit for the market. The lower the temperature to which it is cooled, the better. If cooled to 50 degrees F. the bacteria become inactive and the milk will keep for a reasonable length of time. The use of ice makes it possible to cool to a temperature low enough for all practical purposes. Where ice is not available, the milk should be cooled to at least the temperature of the well or spring water used on the farm. The simplest way of cooling milk on the farm is to pour it into ten-gallon cans and set the cans into a trough filled with cold water or ice water, or through which a constant stream of cold water is running. The milk should be occasionally stirred while in the trough to hasten its cooling.

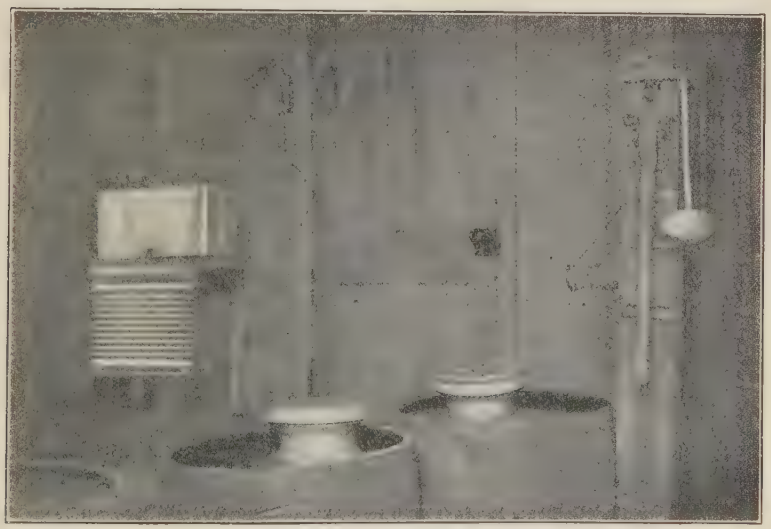


Fig. 15. The milk can be cooled down and kept cool by setting the can in cold water

The milk can be cooled more quickly and more efficiently by the use of a special cooler which is either filled with cold water or through which cold water runs continuously, and the milk trickles in a thin layer over the cooling surface, aerating and cooling simultaneously. When the milk leaves the cooler it has practically the temperature of the water.

Storage and Transportation.—If the milk is peddled off the wagon, it is best bottled on the farm. The bottles are sealed with

paraffined paper caps and placed in cold water or ice water until they leave the farm. Where ice is available, the bottles are best packed in crushed ice in boxes holding 12 to 24 bottles. The boxes are loaded on the wagon and the milk peddled from these boxes. For the peddling of milk, a clean and covered wagon is most desirable. If an open wagon is used, the cans or bottles should be covered with a wet canvas in summer and a dry blanket in winter. The tickets needed by the milk man should be used only once. Old tickets are filthy as old greenbacks. All cans and bottles should be thoroughly washed and scalded on the farm before use.

Where the milk is hauled to the shipping station it should receive the same protection from heat, cold and dirt in transit as where it is peddled. It is advisable to take it to the station at train time. If it must be left there any length of time, a covered shed in which to store the milk should be provided until it can be placed on the cars. If the cans could be placed in a tank containing cold water, it would be preferable. For long-distance hauls the milk should be shipped in refrigerator cars. All cans filled with milk should be sealed and remain sealed until they reach the dealer.

Milk or cream hauled or shipped to the creamery, cheese factory, city milk plant, condensory or ice cream factory, should receive the same protection in transit as that which supplies the consumer direct.

THE CONSUMER AS A FACTOR IN PRODUCING SANITARY MILK

The consumer's attitude towards the quality of milk is of the utmost importance and his verdict goes a long way in raising or lowering the standard of milk. If he appreciates the true value of clean and wholesome milk, if he is willing to pay for it, if he demands it, he will furnish the dairyman with the most potent incentive to produce sanitary milk. The demand for a commodity usually precedes the supply. The supply adjusts itself to the demand. If the public really demands sanitary milk, is willing to pay for it and refuses to accept unclean milk, the dairyman will not be long in supplying that demand. On the other hand, there can be but little real and consistent improvement in the production of sanitary milk so long as the consumer regards milk simply as a household necessity, which is to be bought as cheaply as possible, regardless of quality.

PURDUE UNIVERSITY
Agricultural Experiment Station

Circular No. 21

LaFayette, Ind., February, 1910

AGRICULTURAL EXTENSION
V

SPRAYING THE ORCHARD

C. G. Woodbury

It is the purpose of this circular to give brief practical directions for combatting some of the most common pests of Indiana orchards. No attempt is made to give directions for controlling all the insects and diseases which are found about our fruit trees. It may be said, however, that the troubles here touched upon are the most common ones and if they are overcome by intelligent orchard practice, most of the losses from other insects and diseases will be avoided in the process. The information upon which the recommendations in this circular are based is derived from many sources and may be taken to represent, in very condensed form the substance of the best spraying knowledge and practice to date, concerning the pests mentioned. Improvements and new discoveries are being made, however, and it is likely that the recommendations for 1910 may need to be modified in time to come.

SPRAYING IS NECESSARY TO GROW GOOD FRUIT

Every owner of fruit trees should plan to give them some attention in the way of spraying. Spraying is *essential* to the continued production of good fruit. After years of the most forcible object lessons in the way of regular yields and good profits from sprayed orchards and irregular yields and no profits from unsprayed orchards, the fact still remains that many owners of fruit trees do

not yet realize the importance of the subject. It cannot be doubted on the other hand, that many possessors of orchards realize something of the importance of spraying, pruning and other measures of orchard hygiene, and yet fail to begin this work because they regard it as complex, hard to understand, difficult to accomplish, disagreeable and expensive. Spraying is none of these. The principles are few and easy to learn. The work is not complex and considering the results that follow it, is very inexpensive. Spraying is insurance. Spraying pays.

In order to obtain results, however, it is necessary for the fruit grower to spray intelligently. He must know what he is spraying for; he must know something of the life history of the insect or disease in question so that he can prepare his material and time its

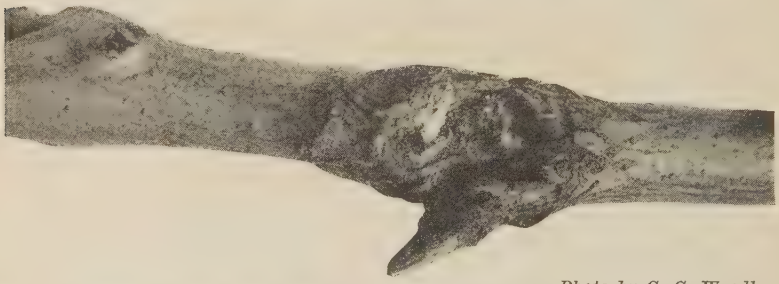


Photo by C. G. Woodbury

Fig. 1. Canker caused by bitter rot. Prune out diseased limbs and remove rotten fruits. Spray with Bordeaux

application most effectively. He must have the right kind of an outfit—one capable of doing good work and not a makeshift appliance made solely to sell.

WHAT TO SPRAY FOR

1. The Apple and Pear.

Bitter rot.—This is a fungous disease affecting the fruit and causing cankers on the limbs. The bitter rot usually develops late in the season and should be thoroughly treated with Bordeaux mixture, two to four sprayings often being necessary to control it. The cankered limbs should be removed promptly and the mummified fruits should not be allowed to remain in the orchard over winter, as the disease is often carried over in this way.

Black rot.—This fungus affects fruit, leaves and branches. The spotting of the leaves and the cankers on the twigs are especially serious. The treatment is spraying with Bordeaux mixture. If the preceding disease and the scab are controlled there is likely to be

little danger from black rot. In addition to the spray treatment, the small cankered limbs should be removed and the cankered area cut away to live wood on the larger limbs, after which the wound should be given a heavy coat of thick paint.

Borers.—These insects work inside of the tree and are effectually protected from sprays. The best remedy for borers in the apple and pear is to watch the tree and dig out the borers when the castings appear at the surface.

Bud moth.—The caterpillars of the bud moth are small, dirty white in color, slightly less than one-fourth of an inch long. The opening buds are sometimes attacked by them in spring. The remedy is to spray with arsenate of lead or Paris green just before the buds open.

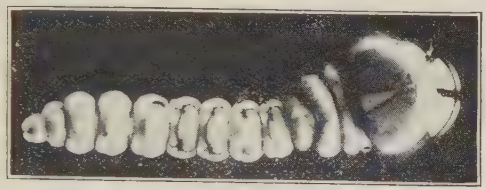


Photo by Demaree and Stevens

Fig. 2. Flat headed apple tree borer. (About twice natural size) Dig out when castings appear at surface

Canker worm.—The canker worm caterpillars are foliage eaters, and do not usually appear early in the season. The remedy is to spray with some form of arsenic, preferably arsenate of lead, as soon as this pest is discovered. Arsenate of lead for this purpose should be used at the rate of three to four pounds to each 50 gallons of water.

Codling moth.—It is the larva or young of this insect that is responsible for our wormy apples. The life history of the insect is given in our Circular No. 17. The treatment is to spray with an arsenical poison, Paris green or arsenate of lead, immediately after the petals fall, using three pounds of arsenate of lead to 50 gallons of Bordeaux mixture or of water. If Paris green is used it should be at the rate of from six to eight ounces to each 50 gallons of spray. This spraying should be repeated in about 10 days. Where the second brood of codling moth causes damage, a further spraying should be given, in northern Indiana in the latter part of July, in southern Indiana about two weeks earlier. The first codling moth spraying given just after the petals fall, should be as thorough as it can possibly be made. Try to get some of the poison in the open calyx throat of every blossom on the tree.

Curculio.—This is a small beetle whose egg is laid in the spring under the skin of the young fruit. Later in the season the beetles continue to puncture the skin of the fruit for feeding. In parts of the state the curculio (plum) does considerable damage, causing the apples which are "stung" to grow deformed and one-sided. The remedy is to spray with an arsenical poison three or four times during the season. Arsenate of lead should be used at the rate of two to three pounds to 50 gallons of water. The first spraying should be given just after the petals fall, the second in from 10 days to two weeks following the first and a third from 10 days to two weeks following the second.*

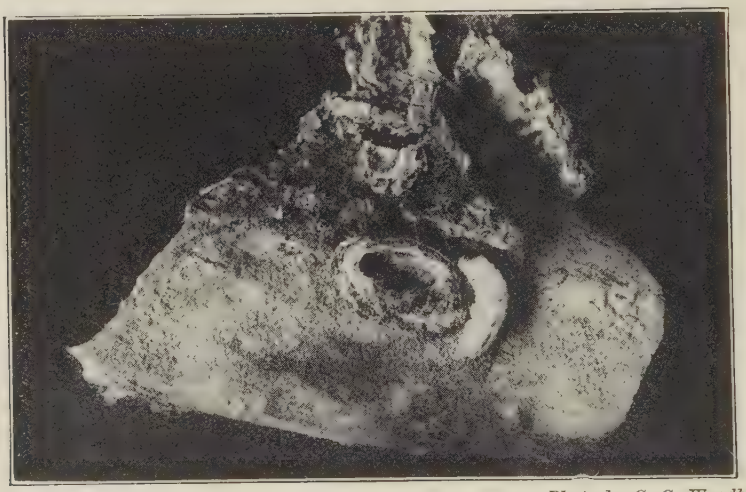


Photo by C. G. Woodbury

Fig. 3. Codling moth larva beside cocoon in which winter is passed. Spray three times with arsenate of lead, during spring and summer

Fire blight.—This is a bacterial disease and cannot be controlled by spraying alone. It is commonly known also as twig blight and pear blight. It often kills back the growing tips of the branches for a foot or more, the leaves turning black and hanging on and giving the tree the appearance of having been scorched by fire. The disease also causes cankers on the larger limbs, often working down into the main crotches and causing the death of the tree. The disease spreads fastest in trees that are making a rapid, sappy growth. It can often be checked by seeding the orchard down and withholding fertilizers, especially stable manure. This checks the growth of

*See Bulletin No. 21, Missouri State Fruit Experiment Station, Mountain Grove, Mo.

the trees and causes them to ripen their wood more thoroughly, thereby becoming more resistant to the disease. Fire blight can be overcome by thorough and persistent cutting out of affected branches. The blighted twigs should be cut off and the cankers on the limbs cut back to live wood and painted. It is very important that pruning tools be sterilized by wiping with some antiseptic ma-



Photo by W. R. Butler

Fig. 4. Fire blight canker on apple. Prune out dead twigs, dress and paint large cankers, and grow trees slowly

terial between trees, as the infection, on account of its bacterial nature, is frequently carried from tree to tree by this means. Some varieties of apples and pears, such as Bartlett and Clapp pears and Yellow Transparent apple are very susceptible to blight. Among pears, the Kieffer and Tyson seem to be most resistant.

Plant lice.—Several species of aphids or plant lice are known to

infest our orchard trees. They are tiny insects, usually green in color, though some kinds are black, and may be found clustered about the stems and on the under sides of the leaves, where they live by sucking the plant juices. They multiply very rapidly and are difficult to combat, owing to the fact that they cause the infested leaves to curl, thus protecting them in large measure from the reach of spray materials. Some plant lice pass the winter in the egg stage, appearing as minute shining black dots on the bark. The application during the winter or early spring of caustic washes, such as the lime-sulfur wash for San Jose scale, will do much to destroy the



Photo by C. G. Woodbury

Fig. 5. Cedar apple on red cedar. This is one stage of the rust fungus which affects the apple

eggs and protect the trees from subsequent attack. Where they are causing injury in the spring or summer, an application of kerosene emulsion (stock solution diluted with 15 volumes of water) should be given. Whale-oil soap solution may be substituted, using one pound of soap to seven gallons of water.

Rust.—This is a fungus which in some parts of the state, especially the southern, often works considerable injury. One stage of this disease is passed on the red cedar, appearing in the spring as the familiar cedar apple. From the cedar apple the spores of the disease are spread to the orchard, causing orange colored spots on

the surface of the apple leaves. The remedy is to cut down all red cedar trees in the vicinity of the orchard, and to spray with Bordeaux mixture.

Scab.—This fungus probably causes more damage to the apples of the state than any other disease of its class. It attacks the fruit, the leaves and the blossom stems. It is the cause of the premature dropping of much of the young fruit. On the young leaves it appears in the form of brown spots; on the fruit it causes dark brown blotches which become roughened, corky and in bad cases cracked, deforming the fruit and rendering it unsalable. The remedy is spraying with Bordeaux mixture. The first application should be

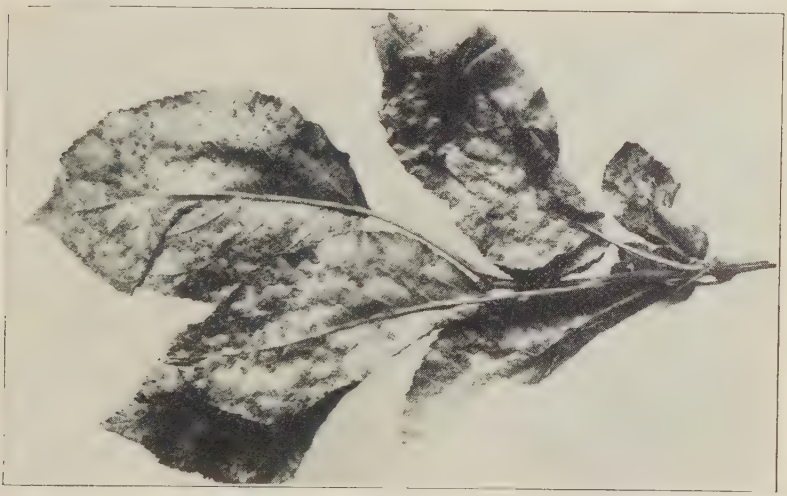


Photo by B. R. Ryall

Fig. 6. Rust on apple. Remove red cedar trees from vicinity of orchard and use Bordeaux

made just before the flower buds open. This treatment should be repeated soon after the petals fall and again about two weeks later. The lime-sulfur wash for scale if applied just before the buds swell in the spring, is of considerable value in preventing scab and if the disease is not very prevalent in the orchard, the lime-sulfur spray may replace the first application of Bordeaux. Clean cultivation is helpful in controlling scab, by removing or burying the old leaves on which the disease passes the winter.

Scale—San Jose.—For full description and discussion of San Jose scale, see our Bulletin No. 138. The San Jose scale is undoubtedly killing more fruit trees at the present time than any other

pest with which we have to contend. It attacks tree, fruit and leaves and kills the tree in a few seasons. The remedy is a thorough application of the lime-sulfur wash or one of the miscible oil sprays when the trees are dormant, after the leaves are off in the fall or before the buds open in spring.

Scale—Oyster shell and Scurfy.—These are two other scale insects that do considerable damage and while not resembling San Jose scale in appearance are often mistaken for it. The oyster shell scale is very convex, brown in color, elongate and slightly curved. The scrufy scale is white or gray in color, flat, pointed at one end and roughly triangular or pear shaped in outline. It is very common

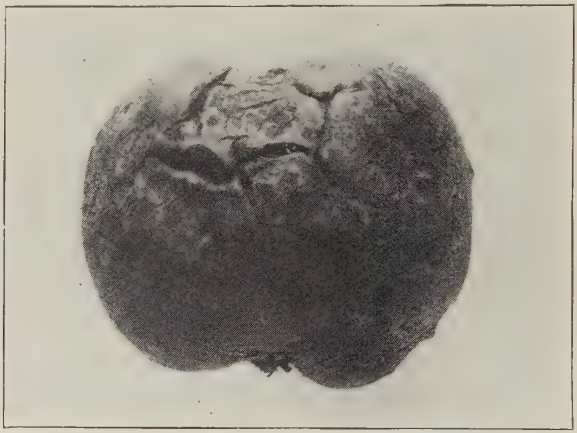


Photo by B. R. Ryall

Fig. 7. Apple badly affected with the scab fungus. Spray with Bordeaux in spring

on apple. Both these scales pass the winter in the egg stage beneath the scale, the eggs hatching in the spring. There is probably but one brood a year. Neither one often becomes thick enough to cause the death of a mature tree. Young apples and pears are sometimes severely injured or killed. The lime-sulfur wash applied as for San Jose scale is helpful in controlling them or a weak kerosene emulsion may be used in early summer when the eggs are hatching.

Tent caterpillar.—These insects often appear in spring in the neglected orchard, spinning their large unsightly webs and defoliating the trees. The caterpillars collect in the webs at night and may be destroyed by burning. Spraying with arsente of lead, three pounds to 50 gallons of water, or Paris green, eight ounces to 50 gallons of water, is also efficient.

Woolly aphis.—This plant louse may often be found in the cracks and crevices of the bark, in the crotches and around the axils of the leaves or around the edges of a wound. Its presence is revealed by the small whitish tufts of wool which give it its common name. It also works on the fibrous roots of the trees, causing irregular knotty growths. It may be destroyed by spraying with kerosene emulsion. For the underground infestation some benefit may follow the application of kerosene emulsion to the roots after the soil has been dug away to expose them, the soil being replaced after the application.

2. The Peach, Plum and Cherry.

Aphis.—As with the apple and pear, we find several species of aphids or plant lice affecting the peach, plum and cherry. The black

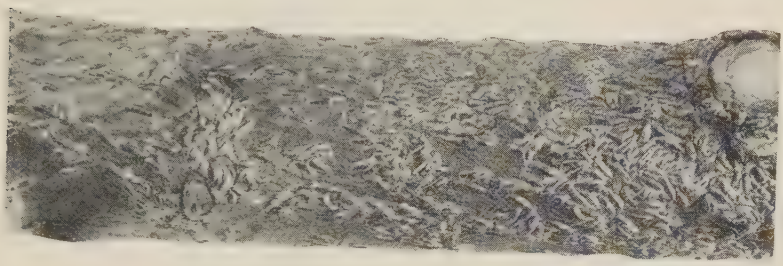


Photo by C. G. Woodbury

Fig. 8. Oyster shell scale on apple. (Natural size) Spray with lime-sulfur while trees are dormant or kerosene emulsion when eggs hatch in the spring

peach aphis is one of the most dangerous, since like the woolly aphis, it may affect both top and roots. In general, the same remedies apply for controlling plant lice on peach and cherry as on apple. Spraying with dilute kerosene emulsion (bending over the branches and dipping is sometimes substituted in case of young trees) and with the underground infestation, the digging in of a liberal application of tobacco dust about the infested tree, is to be recommended.

Black knot.—This is a fungous disease principally affecting the plum though occasionally the cherry also is infested. The disease is characterized by the appearance on the branches of irregular, black, rough, knot-like growths. Spraying for black knot is not effective by itself, though the application of Bordeaux mixture is helpful in controlling its spread. It is necessary to cut out and burn the diseased branches promptly, making the cut some distance below the point where the disease shows. In localities where this disease is prevalent, neighborhood cooperation in stamping it out is very desirable.

Borers.—The peach borer is one of the insect pests of the peach which is difficult to combat and spraying cannot be relied upon. The orchard should be gone over in spring and fall and the borer dug out. Mounding up the young trees with soil is helpful.

Brown rot.—This fungus is often very destructive on peach, plum and cherry. The early peach crop is often entirely ruined by it. The disease passes the winter on the dried-up, mummified fruits, which are often allowed to remain on or beneath the tree and which serve as starting points for the disease the following season. All such fruits should be removed from the orchard and destroyed. The tree should be sprayed with Bordeaux before the blooms open and later at intervals of two weeks if the season is warm and damp, such weather conditions being favorable to the rapid spread of the



Photo by C. G. Woodbury

Fig. 9. Scurfy scale on apple. (About natural size) Spray with lime-sulfur while trees are dormant or with kerosene emulsion when eggs are hatching in the spring

trouble. When the disease is once started it is almost impossible to check it. The later applications of Bordeaux should contain only one-half the standard amount of blue stone, as full strength Bordeaux is likely to injure the foliage of the peach. Thinning the fruit so that no two peaches are less than six inches apart and no two plums touch is excellent orchard practice and also aids materially in checking the brown rot.

Curculio.—Members of this family of small snout beetles work on plum, peach and cherry as well as the apple. The egg is laid in spring under the skin of the young fruit, by adults which have passed the winter concealed in rubbish. The larva develops in the fruit, causing it to drop, when it leaves the fruit, enters the ground and changes to the adult or beetle stage. The adults feed for a short time in spring and thorough applications of arsenate of lead

as soon as the leaves come out are beneficial. Spring cultivation also helps by destroying the pupal cells of the young in the ground. Jarring of the trees is often practiced successfully also. The curculio beetles drop to the ground when the trees are jarred in morning or evening and are caught on sheets and destroyed.

Leaf curl.—This fungus causes much injury to neglected peach orchards, often defoliating them by mid-season. The leaves become swollen and curled and turn to a reddish brown color. The treatment is preventive and consists in spraying with Bordeaux early in spring just before the buds open. Lime-sulfur used at this time has been found to be as effective for this purpose as Bordeaux.

Scale.—The San Jose scale is probably more destructive to the peach than to any other fruit tree. The plum is also very suscepti-



Photo by C. G. Woodbury

Fig. 10. Black knot on plum. Cut out diseased branches promptly some distance below the knots. Spraying with Bordeaux is helpful

ble, but the sour cherry is practically immune. Certain closely related species sometimes attack the cherry, but they are not to be compared to the San Jose in destructiveness. Treatment is the same as for scale on apple. See Bulletin No. 138 for full discussion.

Shot hole fungus.—This disease affects plum and cherry principally, causing the affected portions of the leaves to drop out, leaving round holes suggestive of a charge of bird shot. Trees are frequently defoliated by it. Spray with Bordeaux when the leaves are fully grown and before the disease has appeared if possible. In seasons when the disease is especially prevalent, two or three sprayings at intervals of two or three weeks may be necessary. For peach, the Bordeaux should be used at half strength.

Yellows.—This is a so-called constitutional disease of the peach of unknown origin. It is deadly and apparently contagious. Yel-

lows causes the fruit to ripen prematurely, with red streaks running through the flesh. A wiry tufted twig growth is another symptom. Affected trees should be dug out and burned without delay.

WHAT TO SPRAY WITH

The orchardist has at his command a variety of materials suited to the different insects and diseases which he has to combat. It is



Photo by C. G. Woodbury

Fig. 11. Plum trees about killed with the black knot. It is usually impossible to save trees in this condition

essential for results in spraying that the material used be selected with intelligence and with a definite fore-knowledge of the pest to be controlled. Certain classes of spray materials are useful for the fungous diseases that have been mentioned and certain others for the insect pests. There are also some diseases such as peach yellows

and some insects such as borers where spraying is of no value. With some other insects and diseases such as curculio, fire blight and black knot, the spraying though helpful is not sufficient, and must be supplemented by certain orchard practices such as jarring, thinning the fruit, thorough and systematic pruning, etc., such practices being based accurately upon a fairly comprehensive knowledge of the pest in question.



Photo by C. G. Woodbury

Fig. 12. Apple twig just before flower buds open, showing time for first spraying with Bordeaux for scab

Following are brief directions for preparing the spray materials mentioned in the foregoing pages.

1. Arsenical Poisons for Chewing Insects.

Arsenate of lead.—This is undoubtedly the best form of arsenic for spraying purposes. It does not have the tendency to burn foliage, common to the other arsenicals. It sticks better than Paris green and does not settle so rapidly in the spray tank. For most purposes it should be used at the rate of two or three pounds for each 50 gallons of spray. In practice it is often diluted with Bordeaux instead of water. There are a number of reliable brands on the market—consult the advertisements in the fruit papers, and send for quotations. Arsenate of lead usually comes in the form of a white paste. This paste must be worked up with water slowly till thin enough to dilute easily, when it may be mixed with water or Bordeaux for spraying.

Paris green.—Used at the rate of six to eight ounces to each 50 gallons of spray materials. It should be mixed with a small quantity of water first. If used without Bordeaux mixture, two or three pounds of lime should be slaked and added to each pound of Paris green to counteract the leaf-burning effect of straight Paris green and water.

2. Contact Poisons for Sucking Insects.

Kerosene emulsion.—This is a well known remedy for soft-bodied insects. To prepare it, dissolve one pound hard laundry soap in one gallon of water. If the water is hard, add a little sal-soda to soften it. Put two gallons of kerosene in a warm place so that it will heat without danger to about room temperature or a little warmer. When the soap is dissolved, add the kerosene and agitate violently for five or 10 minutes. This agitation is best accomplished with a small force pump, with which the mixture may be churned



Photo by C. G. Woodbury

Fig. 13. Apples just after petals have fallen, showing time for thorough spraying with arsenate of lead for codling moth. The apple at the left is almost too far along

into itself, thus ensuring a thorough emulsion. A good emulsion should be thick and creamy and of uniform consistency. No free kerosene should separate out on standing. The mixture may be diluted and used at once, or the stock solution may be kept for some time. When cold it curdles like sour milk and should be diluted with three or four times its volume of hot water, before diluting with cold water to spraying strength. The strength to use depends upon the plant to be sprayed. Use one gallon of the stock solution to from 10 to 20 gallons of water.

A superior kerosene emulsion may be made by using whale-oil soap in place of the common laundry soap, since the whale-oil soap has some special insecticidal properties of its own.

Whale-oil soap.—This is an excellent spray for plant-lice and is very easily prepared, needing only to be dissolved. It may be applied in summer or winter. When used in winter at the strength for a dormant spray, it should be applied while hot, as it tends to jellify when cold. Used very strong while the trees are dormant, it is a good spray for the San Jose scale. For this purpose it should be put on late in winter, as there is less danger at that time of its injuring fruit buds, than early in the season.



Photo by C. G. Woodbury

Fig. 14. Apples too far advanced for first codling moth spraying. Not quite time for second

For a summer spray, dissolve
1 pound whale-oil soap in
5 to 7 gallons of water.
For use in winter when the trees are dormant, dissolve
2 pounds whale-oil soap in
1 gallon of water.

Lime-sulfur wash.—For a full discussion of this material see our Bulletin No. 138. It may either be made at home or bought

prepared. This or any spray for San Jose scale is applied while the trees are dormant before growth starts in spring, or after the leaves are off in fall.



Photo by C. G. Woodbury

Fig. 15. An outfit for making Bordeaux. Stock solutions are kept in two of the barrels; the lime water and copper sulfate solution are diluted fully in the other barrels and are mixed by being run together through the trough into the spray tank

Oil sprays.—Some of these brands of ready prepared sprays for San Jose scale do very good work. For discussion, comparison with lime-sulfur and directions for use see Bulletin No. 138.

Bordeaux mixture.—This is by far the most generally useful fungicide we have. The copper sulfate or blue vitriol is the active fungicidal agent, while the lime is added to prevent the burning of the foliage, which would result from a pure copper sulfate solution. The usual formula is:

5 pounds copper sulfate
5 pounds lime
50 gallons of water

Many prefer to modify this formula by reducing the quantity of blue stone one pound and increasing the lime one pound.

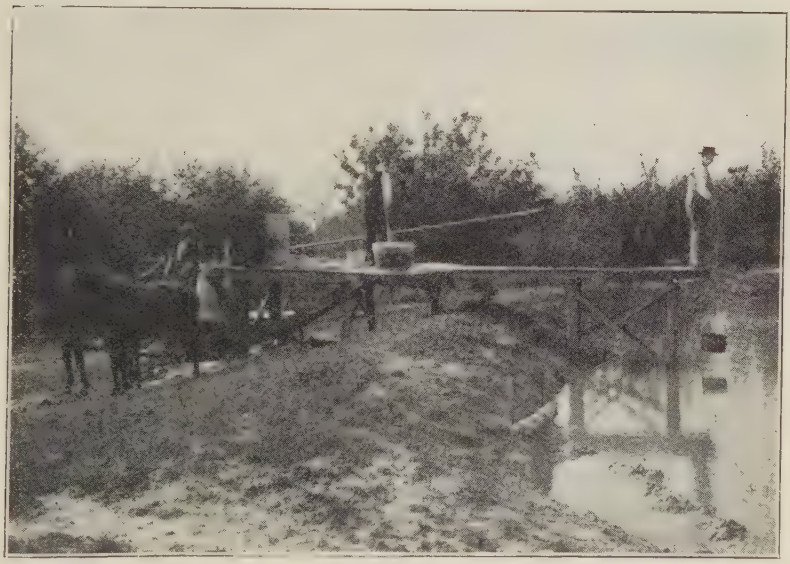


Photo by C. G. Woodbury

Fig. 16. Bordeaux may often be made cheaply and easily by using a pond for water supply and mixing the materials in barrels

Certain precautions must be observed in making Bordeaux, in order to obtain the most efficient mixture. The secret of success is to put together as dilute solutions as possible. The copper sulfate may be conveniently made up into a stock solution by dissolving it at the rate of one pound to one gallon of water. The amount needed at any time can then be readily obtained by stirring up the solution and measuring out as many gallons as there are pounds re-

quired. The lime can likewise be slaked in quantity and kept till needed as a stock solution of known strength. The blue-stone may be dissolved quickly in hot water, or, more slowly, in cold water by suspending near the top of the water in a burlap or coarse basket over night. Good stone lime should be used. Air-slaked lime is not satisfactory. Hydrated or process lime of good quality may be used if the proportion of lime to copper sulfate is increased from one-fourth to one-half. If a barrel (50 gallons) of the Bordeaux is to be made, it is easy to secure the required dilution of material by the use of three vessels. Put 25 gallons of water in the barrel. Dilute the blue-stone solution containing five pounds to 12½ gallons. Dilute five pounds slaked lime likewise, then dip alternately from each solution into the 50 gallon barrel. Whatever the particular method employed, however, the end is the same. Put the copper sulfate and lime solutions together after diluting each as much as possible. Don't mix concentrated solutions. If this is done, with the idea of diluting to spraying strength later, the mixture curdles, and a thick, heavy precipitate is formed which settles so rapidly that it is impossible to do a good job of spraying. A properly made Bordeaux should remain for half an hour with almost no perceptible settling. When putting the spray mixture into the tank, always strain carefully. For peaches use at not over half strength.

SUMMARY OF SPRAYING TREATMENT

Before the reader has come so far, he has realized that one application of Bordeaux mixture or of arsenate of lead, or a combination of the two, might be so timed that it would help control a variety of pests. If this were not true and we had to use entirely different materials at different times for every enemy of our fruits, then indeed spraying would be the complex and troublesome business that many unfortunately imagine it to be at present. As a matter of fact, however, the practical operations of spraying are reduced to a relatively simple basis. We have the lime-sulfur washes and the oil sprays for the scale. We have Bordeaux mixture for fungi and arsenate of lead for chewing insects. The Bordeaux and arsenate combine to form one double purpose spray which will accomplish most of our summer spraying. The scale must be taken care of when the trees are dormant.

The Apple and Pear.—If San Jose scale is present, spray thoroughly with lime-sulfur wash. If the orchard is very scaly give two applications, one in fall after leaves are off and one in spring before leaves appear.

Spray with Bordeaux mixture and arsenate of lead (two to three pounds to 50 gallons) in the spring just before blossoms open.

Spray with same mixture immediately after petals fall, giving a very thorough application. Try to fill every calyx cup with spray. If Bordeaux spraying has been done regularly in previous years and there is very little scab present, Bordeaux may be omitted and simply arsenate of lead and water used. Spray with same mixture 10 days to two weeks later.

Spray again with same material about the middle of July in northern part of state, early in July in southern. If bitter rot develops, repeat Bordeaux spraying at intervals of 10 days or two weeks.

Peach, Plum and Cherry.—If scale is present, spray as directed for apple.

Spray peaches with Bordeaux mixture (full strength) or lime-sulfur for leaf curl before buds swell in spring.

Spray just after blossoms fall with Bordeaux and lead arsenate. (Bordeaux half strength for peaches).

Spray with same materials two weeks later.

If brown rot starts to develop, use Bordeaux at once and repeat in 10 days.

A WORD ABOUT THE OUTFIT

It is impossible to do satisfactory spraying with a poor equipment. A good pump well mounted with proper accessories in the way of strainer, nozzles, spraying hose, fittings and extension rod, are all essential to pleasant, economical and efficient work. Get ready to spray before you begin. Have utensils at hand, with Bordeaux mixing outfit fitted up. Order materials ahead of time and then spray promptly and thoroughly. The results will justify the preparation. For home and small commercial orchards, the barrel pump outfit is best. Several suggestions in regard to its use are given in our Circular No. 17.

See this circular for comparison of nozzles and addresses of spray pump manufacturers. For large orchards, a power outfit is essential. The Department of Horticulture of the Experiment Station will be glad to hear from you regarding individual needs and problems in connection with spray materials and spraying outfits, and will give you personal advice and assitance.



Photo by C. G. Woodbury

Fig. 17. Have a good outfit. A high pressure mist spray from a good barrel pump, through a double Vermorel nozzle

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 22

LaFayette, Ind., March, 1910

AGRICULTURAL EXTENSION
VI

THE LOOSE SMUT OF OATS AND STINKING SMUT OF WHEAT AND THEIR PREVENTION

J. C. Arthur A. G. Johnson

ESSENTIALS OF TREATMENT

Spread out the seed on a floor or canvas and sprinkle with a solution of one pound (about one pint) of formalin to 50 gallons of water until thoroughly moist, but not wet enough to pack in the hand. Shovel over repeatedly to distribute the moisture evenly, then shovel into a pile and cover with sacks or canvas for at least two hours. The seed may then be sown at once or may stand until the next day. If to be kept longer, grain should be dried as rapidly as possible by spreading in a thin layer and stirring occasionally with a rake. Avoid reinoculating with smut from smutty sacks or bins after treatment. The solution may be mixed in a barrel and applied with a sprinkling can. Each gallon of this solution is enough for a little more than one bushel of oats, or almost two bushels of wheat.

INTRODUCTION

While the artificial treatment of the various agricultural crops to prevent the enormous yearly ravages of plant diseases should be looked upon, in a way, as more or less temporary expedients to be replaced in time, if possible, by the development of strains of plants highly resistant to the respective diseases, yet the use of such artificial treatment is of immense importance at the present time. Some progress has been made in the development of such disease resistant strains and varieties, yet much more is hoped for. It is always necessary that such varieties should have the other desirable qualities. The immediate problem for the practical grower of plants is how to keep the diseases from his crop. The known preventives should be employed as generally as possible on the respective crops where the diseases occur.

The loose smut of oats, and stinking smut of wheat, also called "bunt," are sources of immense annual losses in the United States, as well as elsewhere, and Indiana's share in these losses is much too great.

The oat crop of Indiana for 1909, according to "Crop Reporter" a reliable monthly publication issued by the Bureau of Statistics, U. S. Department of Agriculture, was 55,510,000 bushels raised from 1,820,000 acres. According to the answers to a circular letter inquiring about the prevalence of various plant diseases in the state for the year, which was sent out by Mr. Frank D. Kern in cooperation with the U. S. Department of Agriculture, oat smut occurred in amounts varying, in the several counties, from one-half per cent. to 25 per cent. Taking even as low a general average as five per cent. which is certainly very conservative, the loss from oat smut would amount to 2,921,579 bushels. This amount valued at 40 cents per bushel would amount to the enormous sum of $1,168,631.60. At a cost of four cents per acre, for formalin, or $72,800 for the state, the seed oats might have been treated so as to prevent the smut. The difference, then, between $1,168,631, the estimated loss from smut and $72,800, the approximate cost of the necessary formalin, aside from the labor required for the treatment, which would have been slight for each farmer, gives a clear balance of $1,095,831 loss, which might have been saved. This sum speaks for itself.

For a number of years this Department carried on very carefully conducted investigations for the control of loose smut of oats, as well as stinking smut of wheat. The supply of the bulletins[1] giving the results of these investigations being nearly exhausted, the present publication is put forth to meet the demand for practical information, and to summarize the conclusions from previous studies. All illustrations in this publication are original: photographs by O. L. Foster, drawings by A. G. Johnson.

[1]Bulletins Nos. 28, 32, 35, 77, 87, 103



Fig. 1. a, Sound head of oats
b, Smutted head at time oats are heading out
c, Remains of smutted head at harvest time

LOOSE SMUT OF OATS

The loose smut of oats is a disease that is more or less common, some years more than others, wherever that crop is grown unless measures have been taken to prevent its occurrence. The disease is caused by a fungus growing within the tissues of the oat plant. This fungus eventually transforms practically the entire head to a black dusty powder. (Fig. 1, b) Such smutted heads are to be found, usually very readily as the oats are heading out, borne on stalks somewhat shorter than normal as a rule, because of the diseased condition, and consequently easily overlooked. Later, at harvest time, practically all of this powdery dust has blown away and scarcely anything but the skeleton of the head remains. (Fig. 1, c) This is very inconspicuous and easily overlooked. Because of these two reasons, oat smut is frequently underestimated.

ESTIMATING SMUT IN A FIELD

The amount of smut in a field of oats may be estimated with fair accuracy by carefully counting the total number of stalks on some definite areas, say three feet square, in representative parts of the field, and at the same time keeping separate count of the number of heads smutted in each lot, whether they be large or small. By dividing the number of smutted heads found by the total number of stalks on each area will give the percentage of smut in each case. By striking an average of the percentages from the several areas, this final result will be a fairly accurate estimate of the amount of smut in the field.

DEVELOPMENT AND SPREAD OF THE DISEASE

The black powdery dust of the smutted head is composed of innumerable, minute bodies, nearly or quite globular, the spores of the smut fungus. (Fig. 2) These smut spores mature thus in the



Fig. 2. Oat smut spores as seen under a microscope, magnified approximately 625 diameters

smutted heads and, being light, are blown about by the wind like dust just at the time when the healthy oats are in bloom. In this way

the spores easily get on to the young sound kernels that are to become the seed for next year's crop. Many smut spores cling to the oat kernels often safely protected within the chaff. When the oats are sown in the spring, the same conditions that favor their germination and growth favor the germination and growth of the smut spores. These latter soon push out minute germination tubes which grow into the tissues of any very young oat plant within reach. Here the smut fungus grows in the form of irregularly branched tubes and absorbs nourishment from its host; nourishment that the oat plant itself should use in producing growth and seed. The smut fungus keeps pace with its host through the season often branching to all the stalks of a stool. The slightly dwarfed condition of the host, which usually occurs, is the only effect of the smut to be seen until the diseased plants head out. Then, instead of a sound head, one appears with kernels and chaff wholly or in part changed to a black dusty powder, masses of spores of the fungus. These spores are now ready to be blown about to find lodgment on sound young oat kernels where they may remain ready to infect the crop the following year after being sown with the seed in the spring. In this way, then, the oat smut fungus lives over from year to year and spreads.

PREVENTIVE MEASURES

Since it is by way of the seed that the disease is carried over from season to season, it is at once apparent that any practicable method of seed treatment that will kill the smut spores without injuring the vitality of the seed is the point of attack. Several methods are known that meet these requirements and the application of some of them for the prevention of oat smut has long been out of the experimental stage. As with many other things, the method used, if efficient, is usually less important than the care and thoroughness of the application. Among the different methods, the formalin treatment still stands unsurpassed for convenience of application and when properly applied is equal to any other in efficiency.

THE FORMALIN TREATMENT

The formalin treatment is very simple. It may be applied with but very little trouble and much profit by any farmer who has loose smut in his oats. The treatment is as follows: spread out the grain to be treated on a floor or canvas and sprinkle (Fig. 3) until thor-

oughly moist with a solution of one pound (about a pint) of formalin[1] to 50 gallons of water.[2] Shovel over repeatedly while sprinkling and afterward so as to distribute the moisture evenly. It is important that every kernel be thoroughly moistened so that the attached spores may be killed. When thoroughly and evenly moist, not quite



Fig. 3. Application of the formalin solution with an ordinary sprinkling can while grain is being shoveled over

wet enough to pack in the hand, the grain should be shoveled into a pile (Fig. 4) or clean bin or wagon-box and covered for at least two hours with sacks or canvas. This time may be increased to over night, if more convenient, without injury to the grain. The seed may

[1]Formalin is a trade name for a solution of formaldehyde gas in water. The standard strength is 40 per cent., which should be insisted upon in purchasing, because a weaker solution may not be effective. Formalin, sometimes called formaldehyde, may be procured or ordered at any drug store. The price varies somewhat but is usually to be had at from 30 to 50 cents per pound. In the local market at LaFayette "40 per cent. Formaldehyde, Merk," which is a good standard grade, may be had in one pound cans at 40 cents each. Buying in original sealed packages in this way makes it certain that it has not been diluted. Bottles or cans containing the liquid should be kept well corked to prevent the gas from escaping, which would weaken the strength. Formalin should be practically as clear as pure water. When it is at all milky it is worthless.

[2]Fifty gallons of this solution are enough for treating about 60 bushels of oats or about 75 bushels of wheat.

now be sown at once.[1] In sowing at once the seeder or drill must be set to sow somewhat more to the acre in order to make up for the swollen condition of the grain. In order to sow two and one-half bushels of oats the seeder or drill should be set to sow about three and one-half bushels. (Wheat: in order to sow one bushel and four quarts, drill should be set to sow one bushel and 18 quarts.) If grain

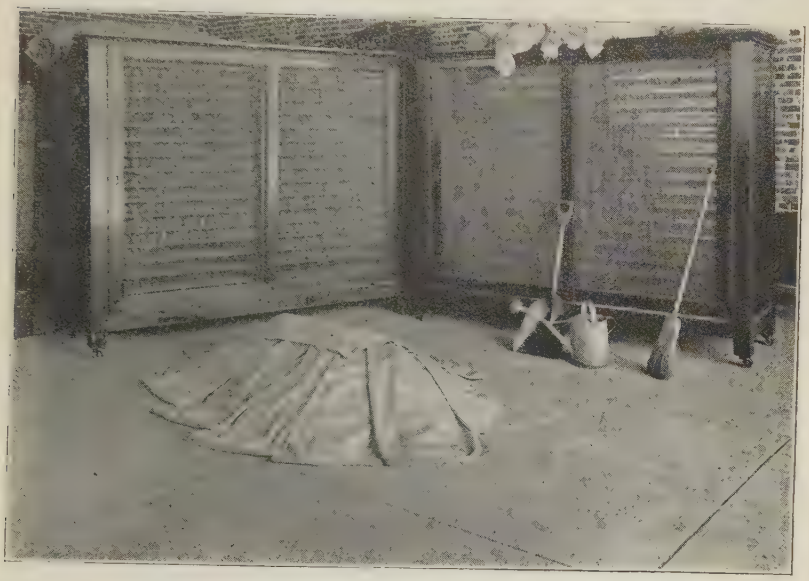


Fig. 4. Pile of grain covered; to be left thus at least two hours

is to be kept longer than over night, it should be dried as rapidly as possible by spreading in a thin layer, where there is a moderate circulation of air, and stirred occasionally with a rake. (Fig. 5) Thorough drying is highly important if grain is to be kept any length of time, for otherwise it will soon heat and spoil entirely. It is usually best to sow as soon as possible after treatment. Care should be taken to avoid reinoculation of treated seed with smut in handling after the treatment, as by using smutty sacks or bins, etc. These may be disinfected by thoroughly wetting for two hours with the formalin solution used for treating the grain. This time may be shortened by using double strength solution. Placing sacks in boiling water for a few minutes is also effective.

[1]If grain is too moist to "feed" well in some seeders or drills, this may be remedied by the addition of land plaster, which will take up the surface moisture. This may be sprinkled on the oats while spread out and the whole well mixed together by shoveling over. When enough has been evenly added the grain will run down the sides of a pile practically as freely as when dry.

In general it is usually best to treat the seed each year unless it is very certain that no reinoculation of the clean crop has taken place either from smut in fields near by, smut spores being carried by the wind, or from smut spores carried by the threshing machine after threshing smutted oats on another farm, or from any other such source.

It is at once apparent that to eradicate oat smut entirely from a community would require the thorough cooperation of all oat grow-



Fig. 5. Drying grain after treatment

ers over a large area. This would be most desirable, but in general, treating the seed each year, or at least every second year, is the safest and most practicable procedure.

STINKING SMUT OF WHEAT

Stinking smut of wheat or "bunt," as it is also called, is quite different from the loose smut of oats in many respects, yet its mode of attack is similar. The two are taken up together in this publication chiefly because of the similarity of preventive measures.

The occurrence of stinking smut of wheat over the state is not so general as that of either the loose smut of oats or the loose smut of wheat. The stinking smut of wheat occurs only where smutty seed

wheat has been used or clean seed has been inoculated with such smut spores in some way in handling. Where this disease does occur, however, it is usually far more destructive than the loose smuts of oats or wheat, sometimes destroying as much as one-half of the crop or even more, and rendering the remainder almost worthless. The same method as with oats can be used for estimating the percentage of smut present in any field. In addition to the amount of grain actually destroyed by the smut, the sound wheat that remains is heavily "docked" on the market because of the well known fact that such wheat produces flour of very poor quality. It is therefore important to give special attention to keeping this smut from the crop or eradicating it if it is present. This can be done. It is necessary, however, to know something of the habits of the fungus which causes the disease so as to be able to proceed intelligently to combat it.

DEVELOPMENT AND SPREAD OF THE DISEASE

The stinking smut of wheat is caused by a parasitic fungus, which, like the oat smut fungus, is carried over from year to year by spores attached to the kernels of the seed grain and sown with them. Infection of the very young wheat plants takes place in a way similar to that with oats. The fungus grows up within the tissues of its host and when the latter heads out the parasite enters the young kernels and transforms the contents of each into a dark brown, dust-like, somewhat greasy, ill-smelling mass, the spores of the fungus. The disagreeable odor given off by this smut, from which character it gets its name, is often so striking at harvest time that it is sometimes noticeable to a considerable distance on the windward side of a badly affected field. This odor is especially noticeable when such wheat is threshed and for some time thereafter in the product.

Thus, instead of heavy, well filled heads of sound wheat, the diseased plants produce heads that are worse than worthless. Such heads are very light and consequently remain usually quite erect. The glumes or chaff of the affected heads are not attacked by this smut. They are, however, often abnormally distended by the short, puffy smutted kernels, which sometimes show between them. In general appearance the smutted heads are similar to the sound ones;



Fig. 6. **a, Head of wheat entirely destroyed by stinking smut**
b, Sound head of wheat
(Both heads of natural size)

(Fig. 6 a, b) when the smutted kernels are examined, however, a rather striking difference is at once evident. The smutted kernels or "smut balls" are of a dead, light brown color, often with an olive green tint. In form they are usually shorter and thicker than the sound kernels and the characteristic deep crease of the latter is no

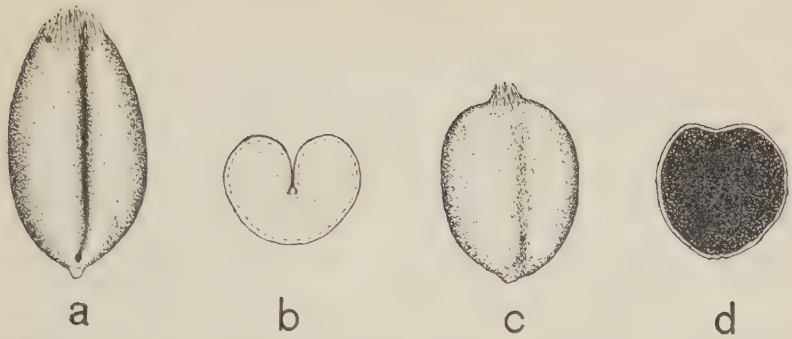


Fig. 7. **a, Sound kernel of wheat**
b, Cross section of sound kernel of wheat showing plumpness, starchy contents, and characteristic crease
c, Smutted kernel or "smut ball"
d, Cross section of smutted kernel showing crease no longer present. Contents entirely transformed to a dark brown mass of spores of the stinking smut
(All four figures are enlarged five diameters)

longer present. (Fig. 7) This gives the "smut balls" their characteristic puffy appearance. The smutted kernels remain whole until broken in some mechanical way in handling the grain. When thus



Fig. 8. Spores of stinking smut of wheat as seen under a microscope, magnified approximately 625 diameters

broken the spores (Fig. 8) attach themselves to anything with which they come in contact, such as the threshing machine and all other sorts of machinery and implements, bins, sacks, etc., that the smutty grain touches. As a consequence of this, clean wheat passed through any such channels, through which smutty wheat has just passed, takes up the spores, and if used for seed without treatment the resulting crop will be almost certain to have smut in it.

From the very great abundance of spores set free by the broken "smut balls," there is much greater danger of spreading this disease, as above suggested, than in the case with oats. This smut of wheat is scarcely at all distributed by the wind but depends upon the above mentioned means for distribution. Such means are so effective that if the disease is introduced and permitted to run its own course, only a few years would be required before it would practically destroy the entire crop.

PREVENTIVE TREATMENT

It is highly advisable, whenever possible, not to use wheat for seed that is known to contain stinking smut. If wheat known to be clean is not procurable, the smutty wheat should first be thoroughly cleaned with a good fanning mill, using a blast strong enough to blow out the unbroken "smut balls" even if the lighter sound kernels are blown over also. The spores that are attached to the sound kernels can then be killed without hurting the wheat by treating the grain with a formalin solution in the same way as prescribed for oats. (Page 5) To prevent reinoculation with smut after such treatment, the same methods should be used as with oats.

Stinking smut can be eradicated in at least two years by carefully treating the seed wheat and always guarding against all possible sources of reinoculation. The threshing machine is really one of the most important sources to watch, and the greater the cooperation between neighbors using the same machine the better. If this or some other source of possible inoculation can not always be entirely avoided, it is advisable to clean the grain well and apply the formalin treatment carefully and thoroughly before using for seed.

OTHER TREATMENTS FOR LOOSE SMUT OF OATS AND STINKING SMUT OF WHEAT

Treatment with copper sulphate or bluestone solution.—This method was first used in Europe over one hundred years ago for seed treatment to prevent smut. It is especially applicable for stinking smut of wheat. As shown by this Department (Bulletin No. 35), it tends to injure, somewhat, the germination and early growth of oats.

In general there are two methods of applying this treatment: either soaking the seed in a strong solution for a short time or soaking the seed in a weak solution for a long time. Either method is effective. The former has been more generally used because the seed does not become so water-soaked. This treatment consists in soaking the seed grain for five minutes in a solution of one pound of copper sulphate to each gallon of water. The treatment with the weaker solution requires the soaking of the seed grain for about 12 hours in a solution of one pound of copper sulphate to each 25 gallons of water. Any gradations of time and strength of solution between these extremes might be used; the object always being to kill the smut spores without endangering the vitality of the grain. After treatment the grain should be drained and dried as rapidly as possible.

It has been found that after the copper sulphate treatment, dipping the grain for a few moments in lime water is advantageous. Such lime water is made by slaking two pounds of good lime and adding 20 gallons of water.

Hot Water Treatment.—This treatment was introduced by Jensen, a Danish investigator, and enlarged and modified in this country. This Department has given extensive careful study to this particular subject. The treatment is used with much success under careful manipulation. It has special merit in treating oats, as it very effectively kills the smut and at the same time accelerates germination and early growth as shown by early studies of this Department. It is most conveniently used where steam is available for heating the water. (Care should be taken to avoid letting live steam come in contact with the grain, as this would kill the seed.)

The treatment consists in soaking the seed grain in hot water for a certain time, after which the grain is spread out to dry. The time of treatment varies with the temperature of the water, which, for success and safety, must be within certain limits: 132° to 140° F. for oats; 132° to 135° F. for wheat. The higher temperatures, uniformly kept, require five minutes soaking of the seed, the lower temperature requires 10 minutes, with corresponding gradations between. If the temperature is somewhat higher than the maximum for a brief portion of the time, no harm will result.

A paragraph from Bulletin No. 35, page 86, summarizes the best method to follow in practice. It it as follows: "Now it is difficult to maintain a uniform temperature for even so short a time as five minutes. The method to be pursued, therefore, is to place the seed in water at 140° to 145°, and allow the temperature to drop as it will, so long as it does not fall below 130°. If, however, it should by accident drop below 130°, the time must be extended over five minutes. After each quantity of seed is treated, the water is brought up to the required temperature again, ready for the next application." This was written for the treatment of oats, consequently for wheat the 140° maximum temperature should be used. The well cleaned grain may be handled in gunny sacks, loosely filled. These should be kept stirred about in the liberal supply of hot water so as to insure uniform treatment throughout. The water should always be kept well mixed so as to insure a uniform temperature throughout.

Sar[1] *Treatment* as given in the U. S. Department of Agriculture Farmers' Bulletin No. 250, where it is recommended for wheat treatment, as follows: "Sar solution is made by mixing 15 pounds of flowers of sulphur with one-half pound of powdered resin, wetting with about 6½ quarts of water to a thick paste, then adding 10 pounds

[1]The word sar was adopted as a short name for this fungicide, being coined from the first letter in each of the words sulphur, alkali and resin.

of dry powdered caustic soda (concentrated lye), stirring vigorously while the whole mass turns reddish brown and boils violently. Enough hot water is added to bring the solution up to 6 gallons. This stock solution is preserved in tightly corked jugs and must be shaken well before being used.

The seed wheat is treated with sar solution as follows: either 1 quart of the solution is diluted with 50 gallons of water and the grain soaked therein for about twelve hours, or else a strong solution (1 gallon of the stock to 50 gallons of water) is used and the grain soaked only two hours. In either case the grain must be stirred several times during the treatment and spread out to dry afterwards. If the grain contains much smut it should first be washed with water in order to skim off the smut balls before it is put in the sar solution to soak." For further details of the process see that bulletin.

THE LOOSE SMUTS OF WHEAT AND BARLEY

The loose smuts of wheat (Fig. 9) and barley are similar to each other and consequently require similar treatments. They destroy practically the entire head, changing kernels and glumes to a mass of odorless black spores. These are blown about by the wind at the flowering time of these crops and infect the young sound kernels. In this way these diseases are carried over from one year to the next.

The formalin treatment as recommended in this circular for other smuts of wheat and oats can not be used with success to prevent the loose smuts of wheat and barley; nor is the copper sulphate method, or the Jensen hot water treatment successful. A modified hot water treatment has been tried with some success and is recommended in a recent bulletin of the U. S. Department of Agriculture, Bureau of Plant Industry (Bulletin No. 152). This method deserves a fair trial, especially since these smuts are sources of heavy losses with these crops and very difficult otherwise to prevent. It is hoped that this modified hot water treatment will prove efficient and practicable. Briefly the treatment recommended, as given in the summary of the above cited publication is as follows: "For barley, a soaking in cold water for five hours, followed by a soaking in hot water for fifteen minutes at a temperature of 52° C. (125.6° F.); for wheat, a soaking in cold water for five hours, followed by a soaking in hot water for ten minutes at a temperature of 54° C. (129.2° F.)". (See that bulletin for further details of the process.)



Fig. 9. a, Sound head of wheat
b, Wheat head at time of heading out, affected with loose smut
c, Same at harvest time with spores blown away
(All of natural size)

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 23

(REVISED EDITION)

LAFAYETTE, IND., JULY, 1911

AGRICULTURAL EXTENSION

VII

HOW TO GROW MORE AND BETTER WHEAT

Indiana grows annually more than 2,500,000 acres of wheat.

The average yield in the state for the past 10 years has been 15.2 bushels per acre.

The cost of producing an acre of wheat in Indiana is about $12.37.

An increase of five bushels in the average yield per acre would mean an annual increase in the value of the crop of $12,500,000.

The average yield of wheat grown under ordinary farm conditions on the Purdue Experiment Station Farm for the past 25 years has been 28 bushels per acre.

Experiments in 10 representative counties of the state have shown an average gain due to fertilization of wheat of 11.6 bushels per acre. The average cost per acre of fertilization was $4.14. leaving a net profit per acre of $7.46.

In a comparison of wheat grown continuously on the same land with wheat grown in a four course rotation containing clover, it was found that the plats in the rotation yielded 5.6 bushels per acre more than the plats in the continuous wheat series.

The Experiment Station believes that with more attention given to the securing of suitable varieties of wheat, proper grading of the seed, rotating of crops, fertilization of the soil, treatment of the seed for diseases and the combating of insects which attack the crops, a material increase in the total production of wheat can be made.

Read this Circular

HOW TO GROW MORE AND BETTER WHEAT

INTRODUCTION

ARTHUR GOSS, Director

This circular was prepared by members of the Experiment Station Staff for the purpose of giving practical information concerning wheat production.

The information presented is based upon a 30 years' experimental study of the subject in the Indiana Station, and upon the most reliable data to be secured elsewhere.

It is evident to every one who has made a close study of the subject that there is imperative need of improvement in the methods of wheat production in use at the present time. The average yield of wheat in the state of Indiana for the past 20 years has been less than 14 bushels per acre.

As the result of an investigation conducted by the Station in 1905 it was found that the average cost of labor and seed for producing an acre of wheat in Indiana was about $7.58. If to this is added the average rental value of the land, which was found to be about $4.79 per acre, the cost of producing an acre of wheat was about $12.37 which is practically all the average crop grown in this state is worth. It is also to be noted that the cost of land and labor has increased considerably since 1905, so that the cost of producing an acre of wheat is now somewhat greater than at that time. It is also true that most of the fertility required to produce a crop of wheat under the present practice is drawn from the soil, so that the above estimate does not include the replacement of sufficient plant food to permanently maintain the fertility, an item which must be considered in any scheme of continuous crop production. It is believed by the Station that it is possible to very largely increase the yield of wheat in this state, and that such an increase can be made at a handsome profit.

While England and several other European countries at one time produced average wheat yields similar to our own, at the present time by the systematic application of the best known methods, the yields in these countries have been enormously increased. The average yield in England for the last 20 years, for example has been over 31 bushels per acre, and the average in Germany during the same time has been over 27 bushels per acre. With the large amount of energy and intelligence possessed by our farmers it does not seem that they should be content with an average of 13 or 14 bushels per acre, while such countries as England and Germany are producing double this amount.

Another thing that leads the Station to believe that the yield of wheat can be largely and profitably increased in Indiana is the fact that the average yield on the Station farm for the past 25 years has been 28.04 bushels per acre. This average is made up from the different check plats used in the variety tests and has included at least half a dozen plats each season. This yield has been secured under ordinary field conditions without the use of any means that could not be easily and profitably applied by any farmer. During the time this average has been secured on the Station farm, the average in the best county in the state has been less than 16 bushels per acre. While the soil on the Station farm will doubtless average somewhat better than the soil of the entire state, it is very doubtful if it will average any better for wheat production than the soil of the best wheat county in the state.

The possibilities of wheat improvement in our state are very great. There are on the average over 2,500,000 acres of wheat sown in the state each year. If we could double our present average yield, which seems in the light of all the knowledge at hand to be entirely possible, it would represent an increase in the wealth of the state, on the basis of our present acreage, of over $32,000,000 annually. Allowing a liberal portion of this for the extra cost of production, the increase would still represent a very large sum. While it is doubtless impossible to double the yield in the state in a single year it would certainly seem to be a practical proposition to increase it at least one bushel per acre, and a single bushel per acre increase would mean a net annual gain in the wealth of the state of over $2,000,000, and of quite as great importance, it would also mean more fertile soil, insuring better succeeding crops.

Considering the rapidly increasing population of the United States, especially in the cities, and the constantly increasing demand for bread-stuff, we are very soon coming to a point where it will be necessary to import wheat unless we increase our production. Under existing conditions the price of wheat must increase rather than decrease, and there is going to be more and more inducement for the farmer to increase his production. Wheat is one of the staple crops in our state and should continue to have a prominent place in our agriculture. In order to continue the growing of wheat successfully, however, our farmers must carefully study the best methods of production such as are outlined in this circular.

CULTURAL METHODS

A. T. Wiancko, Chief in Soils and Crops

THE PLACE OF WHEAT IN THE ROTATION

Wheat should never be grown on the same land continuously. To get good results some kind of a rotation must be practiced; that is, it must be alternated with one or more other crops. What these other crops should be and how many different ones should be included in the rotation will depend upon a number of factors, among which are the kind of farming carried on, the climatic conditions, the kind of soil and its degree of fertility, the kinds of crops that the local conditions will best produce, and the extent to which they can be profitably used in the system of farming followed. One thing, however, is well established and that is that some kind of a legume, usually clover, should have a prominent place in the rotation.

In the crop rotation experiments carried on by the Purdue Experiment Station during the last 20 years, a number of rotations including wheat have been studied. A comparison of these at the present time shows some very interesting results and makes it clear that continuous wheat culture and the culture of wheat in exclusive grain crop rotations are not good practices. The experiments along this line also go to prove that to get the best results, wheat must be alternated with other crops and that the rotation must contain some kind of a legume.

The following table shows the average wheat yields secured in a number of different rotations at this Station, with and without fertilization.

Table I.—Twenty Years Average Wheat Yields in Different Rotations at Purdue Experiment Station, 1890-1909[1]

Treatment	Cropping systems and yields in bushels per acre				
	Continuous wheat	Corn and wheat	Corn, oats, and wheat	Corn, oats, wheat, and clover	Corn, oats, wheat, clover and grass
Unfertilized	15.6	14.2	16.5	19.8	16.8
Fertilized	21.0	25.8	23.9	27.3	24.2

[1] The year 1900 is not included in the averages. The two longer rotations were not in wheat that year and on the others the crop was a total failure on account of Hessian fly and severe winter

In this comparison every factor except crop rotation is eliminated on the unfertilized plats and the differences shown are attributable to the effect of the rotation only. The results show clearly that clover has a decidedly beneficial effect in the rotation and that continuous grain cropping gives considerably smaller yields. On the fertilized plats the difference in favor of rotation is still greater and the four-course rotation containing clover is again decidedly the best. The average increase due to fertilization in continuous wheat culture is only 5.4 bushels per acre, while in the rotations the average increase is 8.5 bushels per acre. The results also show that with liberal fertilization good wheat crops can be grown in almost any kind of a rotation, but the average cost per bushel is greater where only grain crops are grown. When the total crop yields and the cost of fertilization are considered, the rotations with clover give the best results. In the four-course rotation with clover, the average yield of all plats is 5.6 bushels per acre greater than the average of all plats in the continuous wheat series, and four bushels greater than the average of the three series not including clover, in spite of the fact that the average annual fertilization was considerably less, since only grain crops were fertilized. On the unfertilized plats, which are more perfectly comparable, the four-course rotation shows an average yield of 4.2 bushels per acre more than the continuous wheat series and 4.4 bushels per acre more than the average of the three series without clover. At $1.00 per bushel the 4.4 bushels per acre gain on a 20-acre wheat field amounts to $88.00 per year for the grain alone, besides the fact that the average fertilizer cost of the wheat per bushel is less.

The farmer who feeds considerable live stock is in the best position to use a variety of crops profitably. Under Indiana conditions the live stock farmer can usually use the three-course rotation of corn, wheat and clover to the best advantage, as with him, corn and clover are both very necessary crops, and for the most part the natural conditions are favorable to their profitable production. While this is not an ideal rotation so far as the wheat is concerned, on account of the heavy drain on the soil caused by the corn crop, the difficulty can be largely, if not wholly, overcome by giving the wheat better treatment than it usually receives. When the wheat is sown in standing corn, where the ground has not been kept clean and mellow and very little special fertilization is given, it is not fair to expect much of it. During its long season of growth, the corn crop has largely taken the available plant food out of the soil and there is little time for recuperation before sowing the wheat, which consequently develops but slowly and is often not in good condition when winter overtakes it. It is often difficult, too, to get a full, even stand

of plants in standing corn. When wheat is to follow corn in the rotation, the best practice is to cut the corn as early as possible, then thoroughly disk and harrow the ground and sow the wheat with a two-horse drill, using a liberal application of a well proportioned fertilizer as described in another portion of this circular.

Exclusive grain farming is not usually advisable, as without live stock the forage crops in the rotation cannot be used to as good advantage and it is more difficult to keep up the fertility of the soil.

For the greater part of Indiana, when both wheat and corn are to be included in the cropping system, there is no better rotation than corn, wheat, and clover, using cow peas in the place of clover



Fig. 1. A good field of wheat. Average yield 43.2 bushels per acre

when the latter fails, and liberally fertilizing the wheat. On some of the heavy soils of southern Indiana not well adapted to corn, a two-course rotation of wheat and clover with fertilizer on the wheat, may be used to good advantage. While there is as yet little exact data at hand, it seems probable that wherever soy beans or cow peas will do well, a four-course rotation, consisting of corn, soy beans or cow peas, wheat, and clover may be profitably used and is well adapted to keeping up or improving the fertility of the soil. Where clover and grass both do well and can be used to good advantage, the corn, wheat, clover and grass rotation with liberal fertilization for the grain crops and a top-dressing for the grass may be recommended.

SOIL PREPARATION

The best methods of preparing the soil for wheat will depend upon the previous crop and the nature of the soil. Where wheat is to be sown in standing corn, the most practical soil preparation consists in thorough cultivation of the corn crop, keeping the soil mellow and free of weeds throughout the summer. A much better practice, however, consists in cutting off the corn and thoroughly disking and harrowing the ground before drilling the wheat, thus insuring a better seed-bed and a more uniform stand. Corn ground should never be plowed for wheat, as it loosens the soil to too great a depth. The sub-surface must be firm for wheat. When wheat follows oats, the ground should be carefully plowed and harrowed as soon as possible after harvesting the oats. Disking the oats stubble before plowing is often advisable, especially if the ground is dry and inclined to break up cloddy. Early plowing in this case is very important, as wheat likes a firm seed-bed and there must be plenty of time for the soil to settle. Just before drilling the wheat, the ground must be again harrowed up fine. When wheat follows clover, the plowing may be somewhat delayed so as to get the benefit of some second-growth clover to plow under, but it is never advisable to delay plowing until just before sowing. When wheat follows such crops as potatoes, soy beans or cow peas, an ideal seed-bed can be prepared by disking and harrowing, and on clean, mellow soils, harrowing only will be sufficient.

TIME OF SEEDING

The best time to sow wheat in Indiana varies from the second week in September in the northern end of the state, to the first week in October in the southern end. On naturally fertile or properly fertilized soil that has been well prepared, seeding may safely be done considerably later than when the conditions for rapid growth are unfavorable.

On account of the almost constant danger of trouble with the Hessian fly it is advisable to delay seeding as late as possible. By late seeding the fly may be more or less completely avoided when an early seeding would have been badly infested. By providing conditions favorable to rapid growth, a good seed-bed and plenty of available plant food, late sown wheat will be just as far ahead when winter comes on as that which is sown early under unfavorable soil conditions. With proper attention to the condition of the soil, the average farmer in Indiana could profitably sow his wheat a week or 10 days later than he usually does. On the University

farm at LaFayette, the best average results are secured by sowing during the last week in September. About one day earlier or later than this should be counted for each 10 miles north or south of this point.

METHODS OF SEEDING

Wheat should always be sown with a drill. A great many of the experiment stations have conducted experiments comparing the relative yields secured from drilling and broadcasting and the results have invariably been in favor of drilling, especially with winter wheat. Drilling insures a more uniform depth of covering for the seed, better germination, and a more uniform stand. It also requires less seed to insure a full stand. Drilled wheat will stand the winter better than that which is broadcasted. The little ridges between drills have an appreciable effect in holding snow and protecting the plants during winter. The heaving of the soil in early spring damages drilled wheat less than that which is broadcasted. The kind of seed-drill used is not important on well prepared, clean ground, but on trashy ground a disk drill will do the best work.

RATE OF SEEDING

The amount of seed per acre required to get the best results depends upon a number of conditions, such as the fertility of the soil, the condition of the seed-bed as to fineness and moisture, and the size and quality of the seed used. With medium sized seed of good quality, on a well prepared and fertile soil, six pecks per acre will usually be found sufficient. Under some conditions four pecks of seed have been found sufficient, while under others, eight to 10 pecks have been found most profitable. Every farmer should be able to determine for himself how much seed should be used under his conditions. The larger the seed, the poorer the soil and the less perfect the seed-bed, the larger the quantity of seed required, and the smaller the seed, the richer the soil and the better the seed-bed, the smaller the quantity of seed required.

SEED SELECTION

The selection of good seed is an important means of increasing the yields of wheat and this factor in wheat production should receive the most careful attention of every farmer.

The more complicated methods of the plant breeder or the specialist in crop improvement cannot usually be practiced by the busy farmer, but he can well afford to select his seed out of the

best portion of his crop and to take pains to grade it in such a way as to get the largest and plumpest seed for sowing.

That it pays well to use large and plump seed, no matter what the variety may be, has been shown in the results secured in numerous experiments along this line. The tables below show the results secured by some of the experiment stations that have conducted the most careful tests along this line through periods of several years.

TABLE II.—Comparisons of Heavy and Light Seed

Stations	Yields in bushels per acre		
	Heavy seed	Light seed	Difference in favor of heavy seed
Minnesota[1]	29.4 bus.	24.8 bus.	4.6 bus.
Nebraska[2]	27.9 "	22.8 "	5.1 "
Kansas[3]	27.1 "	25.2 "	1.9 "
Ontario[3]	38.6 "	33.7 "	4.9 "
Averages	30.7 "	26.6 "	4.1 "

[1] Minnesota Station Bulletin No. 115; [2] Nebraska Station Bulletin No. 72; [3] Bureau of Plant Industry, Bulletin No. 78

TABLE III.—Comparison of Large and Small Seed

Stations	Yields in bushels per acre		
	Large seed	Small seed	Difference in favor of large seed
Indiana[4]	30.5 bus.	27.9 bus.	2.6 bus.
Ohio[5]	16.3 "	16.3 "	0.0 "
Ontario[6]	46.9 "	40.4 "	6.5 "
Tennessee[7]	28.6 "	23.4 "	5.2 "
Averages	30.6 "	27.0 "	3.6 "

[4] Indiana Station Bulletin No. 36; [5] Ohio Station Bulletin No. 165; [6] Ontario Agricultural College Report 1905; [7] Tennessee Station Bulletin No. 4, Vol. XVI

Both the preceding tables show important average gains in favor of heavy and large seed and we are amply justified in concluding that it pays well to take the trouble to grade seed wheat so as to get the largest and heaviest seeds to sow. The gain from careful sifting and grading is due to the fact that the smaller and lighter kernels are less mature and consequently less vigorous and do not produce as thrifty plants as the larger and plumper seeds.

A good fanning mill is the simplest and most practical means of grading seed on the farm and every farmer who grows small grain crops should have one.



Fig. 2. The fanning mill is a simple and effective means of selecting good seed wheat

By careful attention to seed selection, combined with good cultural treatment, any variety of wheat can be improved from year to year. With proper care there is no danger of wheat deteriorating or "running out."

VARIETIES OF WHEAT FOR INDIANA

Indiana belongs to the semi-hard winter wheat territory of the United States. The climatic conditions of the state, and for the most part the soil also, are favorable to the production of wheat of

better than average quality and we are fortunate in having a large number of varieties that possess, in a more or less marked degree, qualities that make them desirable from the standpoint of both the farmer and the miller.

In the selection of varieties, the most important points to be considered are winter hardiness, stiffness of straw, high yielding power and good milling quality. Among the hundreds of varieties that have been tested at this Station there are several that may be safely recommended for general use and among these are Rudy, Grains O' Gold, Farmer's Friend, Mealy, Winter King, Poole, Harvest King, Farmer's Trust, Michigan Amber, Egyptian Amber, Reliable, and Fultz. All of these varieties have proved themselves to be good yielders while at the same time ranking high in milling qualities. Of these varieties the Mealy, Reliable and Rudy are usually a couple of days later in maturing than the others and the Mealy is inclined to suffer from shriveling. Rudy, Farmer's Friend, and Winter King have particularly large, fine looking kernels, while the Mealy kernel is below average in size. On especially rich ground the Egyptian Amber, Farmer's Friend, Rudy and Winter King are inclined to be weak in the straw, largely due, in the case of the last three, to their inclination to grow tall. Mealy is also inclined to grow taller than the average, but the straw is quite stiff. Gold Coin, Niagara, Abundance, Tennessee Fultz, New American Banner, and Dawson's Golden Chaff are also to be found among the better yielders with good stiff straw and other desirable characteristics, but they are more or less lacking in milling quality and for that reason are not so desirable as those first named. The hard Russian varieties, Kharkov and Turkish Red, which have been found very desirable in other parts of the country, especially where the climate is drier, produce an excellent quality of grain in Indiana and are quite hardy but have not proved to be good yielders and are particularly inclined to be weak in the straw and lodge easily.

The following table shows some of the higher and lower yielding varieties of wheat tested at this Station during recent years and illustrates very forcibly the wide differences in practical value that may exist between varieties. The best half dozen varieties have averaged over five bushels per acre above the poorest half dozen, and the difference between the best and poorest is nine bushels per acre.

TABLE IV.—Average Yields of the Highest and Lowest Yielding Varieties of Winter Wheat Tested at Purdue from 1906 to 1910, Inclusive

Highest yielders	Bushels per acre	Lowest yielders	Bushels per acre
Rudy	30.0	Old Ironclad	21.0
Pearl's Prolific	26.7	Wheedling	21.7
Michigan Amber	26.5	Queen of New York	21.9
Farmer's Friend	26.5	White Golden Cross	22.0
Egyptian Amber	26.2	Red Fultz	22.1
Abundance	26.0	Bulgarian	22.3
Average	27.0	Average	21.8

Many Indiana farmers are growing inferior varieties or some of the better varieties named above that are badly mixed and by careless treatment have become inferior. Every farmer who is not satisfied with the wheat he is growing should investigate some of the varieties named above or communicate with the Soils and Crops Department of the Station.

THE MANAGEMENT OF WHEAT AFTER HARVESTING

Much loss to all concerned in the wheat crop results every year from careless management after harvesting. Most of this loss is due to damage sustained by the grain through exposure in the shock before threshing. When wheat stands in the shock for several weeks, exposed to sun and rain, as is commonly the case, the grain loses its brightness and the bran becomes brittle so that when milled, much of it crumbles and passes through the finest silk sieves with the flour, producing inferior grades. Quite frequently more or less injurious fermentation and even sprouting occur in the shock, and the cap sheaves, at any rate, seldom escape serious injury. The average loss due to exposure in the shock probably amounts to at least five cents per bushel in the flour making value of the wheat. Whenever wheat cannot be threshed as soon as it is dry enough, it would undoubtedly pay to carefully stack it, if it cannot be housed, or to use a good grade of canvas shock cover. Stacking is to be preferred and the expense involved will be saved, to a large extent at least, at threshing time and the market value of the grain will be enough higher to pay well for the extra trouble.

MAINTENANCE OF SOIL FERTILITY

ARTHUR GOSS, Director
S. D. CONNER, Chemist Soils and Crops
J. B. ABBOTT, Associate in Soils

PLANT FOOD REQUIREMENTS OF THE WHEAT CROP

One of the principal causes of failure to secure satisfactory yields of wheat in Indiana at the present time is lack of proper attention to the matter of feeding or fertilizing the crop. There is no doubt that our farmers will have to pay more attention to this point if they wish to grow wheat at a profit. It is just as necessary to have an adequate supply of food available for a crop of wheat as it is to have plenty of food at hand in order to grow a drove of hogs.

The food used by the wheat crop consists of compounds of about a dozen of the chemical elements, most of which are derived from the soil. All of these food elements must be present or the crop cannot grow. Just as an animal must have salt and various other substances in its food, so must wheat have nitrogen, phosphorus, potash, lime and a number of other elements in its food. If any of the essential food elements are lacking, the plant will not develop.

Fortunately most of the food elements used by wheat are present in the soil in abundant quantity, but there are three, namely nitrogen, phosphorus and potash, which are used by wheat and other crops in large amounts, that are present in the soil in small amounts; hence, after a few years cropping accompanied by the removal of the produce from the land, the available portion of these elements becomes exhausted and in order to secure further satisfactory yields, these food elements must be added to the soil from some outside source. The principal and most common sources of plant food, aside from the soil, are barnyard manure and commercial fertilizers.

In considering the use of fertilizers, the fact must not be overlooked that the fertility of the soil is dependent upon a considerable number of factors other than the presence of adequate amounts of plant food. Some of the most important of these are good water supply and drainage, good physical condition of the soil, good cultivation, conditions favoring the development of beneficial soil bacteria, absence of harmful materials and bacterial growths, an adequate supply of humus, and sufficient lime or other alkaline material to keep the soil from becoming acid. Unless these essential factors of plant growth are present, the feeding or fertilizing of the crop cannot be expected to produce satisfactory results any more than the feeding of an animal under unsanitary or unhealthful conditions can be expected to produce satisfactory results.

EFFECT OF FERTILIZERS ON WHEAT

Clay Soil—Scott County

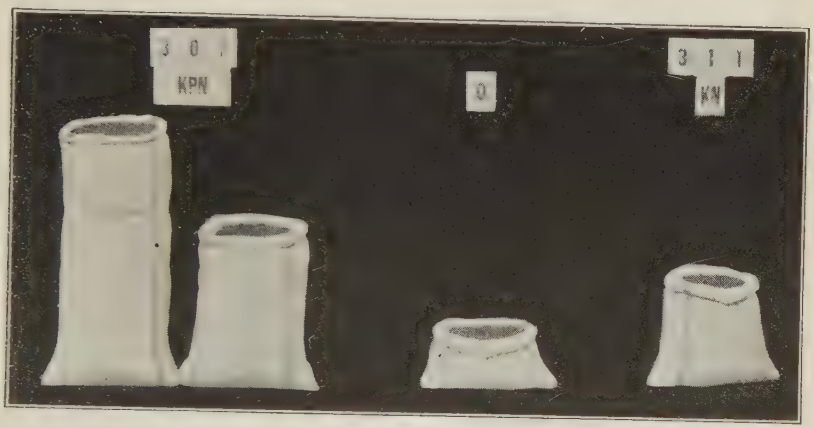


Fig. 3

30.8 bushels per acre
Dried blood 60 lbs. per acre
Acid phosphate 200 lbs. per acre
Muriate of potash 30 lbs. per acre
Cost of fertilizer per acre $3.20

4.2 bushels per acre
Not fertilized

9.5 bushels per acre
Dried blood
60 lbs. per acre
Muriate of potash
30 lbs. per acre

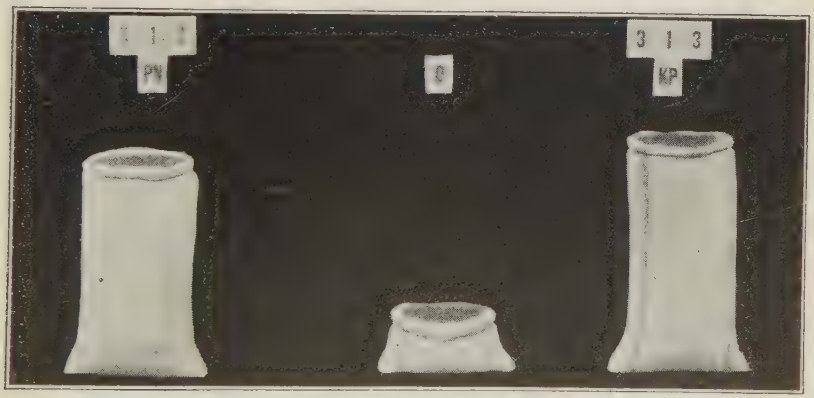


Fig. 4

21.3 bushels per acre
Dried blood 60 lbs. per acre
Acid phosphate 200 lbs. per acre

4.2 bushels per acre
Not fertilized

22.6 bushels per acre
Acid phosphate
200 lbs. per acre
Muriate of potash
30 lbs. per acre

Wheat responds to the use of fertilizers more readily than most of the other ordinary crops. This is due largely to the fact that wheat makes the principal part of its growth during a comparatively short period and requires an abundant supply of readily available food at that time. Then again wheat is a comparatively shallow rooted crop and does not have access to the depth of soil available to deeper rooted crops and consequently must have an abundant supply of available food in the surface soil.

STATION FERTILIZER TESTS WITH WHEAT

Besides the investigation concerning the fertilization of the wheat crop that has been in progress on the Experiment Station Farm at LaFayette for the past 25 or 30 years, mention of which is made elsewhere in this circular, the Station for a number of years past has been conducting field experiments on wheat fertilization in co-operation with farmers in various parts of the state. Such experiments have been carried to successful conclusions on every important soil type in the state, and it seems fair to take the mean average result of these experiments as indicating in a general way the possible state-wide improvement in the wheat crop which can be brought about by systematic fertilization.

Taking 10 representative one year experiments from the following widely separated locations, Scott, Fayette, Ripley, Sullivan, Clinton, DeKalb, Bartholomew, Johnson, Tippecanoe and St. Joseph counties, it has been found that the average gain in bushels per acre due to fertilization[1] has been 11.6, the average cost per acre of fertilization has been $4.14 and the average net profit per acre has been $7.46. To this profit must also be added the benefit accruing to the land from the residual fertilizer left behind by the wheat crop and benefiting future crops.

It has been repeatedly shown that fertilizer shows marked results for one or more years after the application, depending on the kind and amount used, and that the proper use of fertilizers on the wheat crop is quite generally of great assistance in securing a good stand of clover and in causing it to grow into a good crop. The increased crop of clover, of course, increases the prospect of a good corn crop, so all in all it seems that the first direct profit from wheat fertilization may be but the smaller part of the total profit.

It is to be noted, however, that the results mentioned above were not obtained by haphazard methods of buying and putting on the soil an insignificant amount of anything sold as a fertilizer with

[1] 300 pounds per acre of fertilizer containing four per cent. nitrogen, eight per cent. phosphoric acid and four per cent. potash

an eye mainly to cheapness, nor can satisfactory results be so obtained. They are the result of patient study and experimentation and only in just such manner can the results mentioned be equaled, for in treating the soil the old saying, "One man's food, another man's poison," holds good to the extent that a fertilizer which gives good results on one kind of soil may be used at a dead loss on a different kind of soil. Any one who is unwilling to give a little intelligent thought to problems of soil fertility, might better keep his money in his pocket than buy and use fertilizer by guess, for the profits shown above are not for him except by chance. Information, however, is easy of access. The Experiment Station and the United States Department of Agriculture may be freely consulted and there are a number of excellent books on soil fertility written in non-technical terms that any one can understand, and the study of such books cannot be too strongly urged.

FERTILIZER TEST IN CLINTON COUNTY

Table V shows the results of a fertilizer test in Clinton county in 1907. These results may be regarded as typical of most of the wheat soils of the state, so far as fertilizer requirements are concerned. Naturally the previous treatment of the soil, particularly as regards the use of manures and legumes, modifies conditions somewhat in the direction of lessening the amount of nitrogen required, but in a general way this experiment may be taken as accurately showing the general tendency of the wheat soils in Indiana to be very seriously deficient in phosphoric acid, more or less deficient in nitrogen depending upon the previous treatment, and to a less extent in need of available potash.

TABLE V.—Fertilizer Experiment—Clinton County, 1907

Plat No.	Fertilizer applied 300 pounds at seeding	Bushels per acre	Weight per measured bushel
1	Unfertilized	13	56
2	Nitrogen, 4 per cent. Potash, 4 per cent.	17	57
3	Nitrogen, 4 per cent. Phosphoric acid, 8 per cent. Potash, 4 per cent.	35	60
4	Unfertilized	15	57.5
5	Phosphoric acid, 8 per cent. Potash, 4 per cent.	30	60
6	Nitrogen, 4 per cent. Phosphoric acid, 8 per cent.	33	60
7	Unfertilized	18	57

It will be noted that the wheat from every plat receiving phosphoric acid weighed 60 pounds per measured bushel and graded No. 2, whereas the wheat from the other plats did not weigh as much by two and one-half to four pounds per measured bushel and graded No. 3. This and many other similar experiments indicate that the addition of liberal amounts of plant food to the wheat crop very materially increases not only the yield but the quality as well.

The specific function of phosphoric acid seems to be to promote good seed development and to hasten the ripening of the crop. Nitrogen promotes the growth of the green parts of the plant and causes too rank a growth and lodging, if in excess. Potash aids in the formation of starch and woody tissue in the plant and promotes the development of a good stiff straw with little tendency to lodge.

LIBERAL FERTILIZATION MOST PROFITABLE

The amount of fertilizer used in the Clinton county experiment, 300 pounds per acre, is considerably in excess of the amount commonly used, but that this amount is more profitable the first year than a lighter application, as well as more effective in maintaining the fertility of the soil is indicated by the results of a quantitative experiment in Sullivan county in 1907, given in Table VI.

TABLE VI.—Effect of Increasing Amount of Fertilizer, Sullivan County, 1907

Amount of fertilizer	Bushels per acre	Net profit per acre
Average 3 unfertilized plats	22.4	
Average 2 plats, 100 lbs. per acre	25.6	$1.75
Average 2 plats, 200 lbs. per acre	31	$5.70
Average 2 plats, 400 lbs. per acre	34	$5.80

These results show that it was much more profitable to use 200 pounds per acre than to use only 100 pounds per acre, and that 400 pounds per acre yielded a slightly greater net profit than 200 pounds per acre. Of course the residual effect of the heavier applications is much greater than the residual effect of the lighter applications, and if this factor could be accurately calculated it would make the showing of the heavier applications as compared to the lighter applications even more favorable than is shown in Table VI.

The fertilizer used in this experiment was a complete fertilizer containing 4 per cent. of nitrogen, 9.5 per cent. phosphoric acid and 4 per cent. potash, costing about $29.00 per ton, when home mixed from raw materials at present retail prices. Wheat was valued at $1.00 per bushel.

LASTING EFFECT OF FERTILIZER

The experiment given in Table VII which was conducted in Scott county, shows that when large amounts of fertilizer are used, lasting results are obtained, and when a small application is made there is no great lasting effect. The yield, however, in the latter case does not run below the unfertilized plat, showing that even if there has been no good effect the latter season, neither has there been any bad effect.

TABLE VII.—Clay Soil—Scott County

Fertilizer applied first year only	Corn 1904	Wheat 1905	Corn 1906	Wheat 1907
Amount per acre	Bushels per acre			
No fertilizer	Failure due to drouth	5	18	7
1300 pounds complete fertilizer		22	50	16
160 pounds complete fertilizer		10	21	7

SOIL NOT INJURED BY FERTILIZER

The fear is often expressed that fertilizer may injure the soil and cases are cited which seem to bear out this hypothesis. As a matter of fact the decreasing fertility of certain soils upon which commercial fertilizer has been used is not at all due to the use of the fertilizer but rather to the neglect of other just as essential things such as a good rotation, the use of farm manures, etc., and perhaps in certain cases to the misuse of fertilizer. Commercial fertilizer is probably more commonly misused through a mistaken notion of economy than in any other way; that is, the amount used is at once too small for maximum profit and too small to be of any service in permanently maintaining the fertility of the soil. Such small applications of fertilizer feed the crop during the early part of its growth, but are not sufficient to carry it to maturity. The natural consequence is a somewhat shortened crop, and a heavier draft on the soil than could be made by a less vigorous crop grown without fertilizer from the start. For a few years small applica-

tions of fertilizer may seem to produce about as much effect as larger applications but it is at the expense of the soil and after a few years of such treatment the supply of plant food in the soil becomes so depleted that good results are no longer obtained from the use of small amounts of fertilizer. This condition undoubtedly may be hastened by inadequate fertilization, but it cannot be said to be due to the fertilization in any sense. It is the inevitable result of the removal of plant food from the soil in crops and is bound to come sooner or later, irrespective of the use of small amounts of fertilizer, unless a sufficient amount of plant food is returned to the soil to replace that removed in crops.

The effect of the continued use of abundant amounts of fertilizers on wheat during a long period, is well illustrated in Tables VIII and IX, which are based upon the results of 50 years' work at the Experiment Station at Rothamsted, England.

TABLE VIII.—Continuous Wheat, Rothamsted, England, 1852-1902

Fertilization	Average yield per acre
Untreated	13.1 bus.
Minerals alone	14.9 "
Nitrogen alone	20.7 "
Heavy application complete fertilizer	37.1 "
Barnyard manure	35.7 "

TABLE IX.—Wheat in Four-Course Rotation Including Legume, 1884-1903, Rothamsted, England

Fertilization	Average yield per acre
Untreated	25.3 bus.
Minerals alone	39.7 "
Complete fertilizer	39.1 "

Table VIII shows that 50 years' continuous use of fertilizer not only has not injured the soil, but has maintained it in a high state of fertility, and also that the mineral elements alone have proven inadequate, some source of nitrogen being necessary. The practical solution of this nitrogen problem lies in the introduction of a legume into the rotation as shown in Table IX, thus maintaining the fertility without the use of nitrogenous fertilizers, and re-

sulting in a very material lessening of the cost of fertilization and at the same time securing considerably better results. This, in brief, is the system recommended at the present time, that is the introduction of legumes into the rotation to furnish nitrogen and humus, and liberal use of the mineral elements, phosphoric acid and potash whenever the available supply in the soil sinks low enough so that they can be used at a profit.

THE USE OF LEGUMES AS NITROGEN GATHERERS

The legumes, such as clover, cow peas and soy beans, differ from other families of plants in that their roots are characteristically inhabited by bacteria which utilize the free atmospheric nitrogen during their life processes and leave it in the combined form in the legume in which form it may become available to other plants. Hence, while the growth of a non-legume crop, such as wheat, leaves the soil poorer in nitrogen than before, the reverse is true in case of the legumes. It is not to be understood, however, that legumes derive all their nitrogen from the air, for it has been found that they often derive a very considerable part of it from the soil just as other plants do, and in case the bulk of the legume crop is removed from the land, it probably leaves the soil poorer in nitrogen than before the crop was grown. This emphasizes the importance of feeding legume crops on the farm and taking good care to save the manure, or plowing the crop under directly.

The nitrogen gathering bacteria of the legume roots do not thrive in a wet, cold soil or in a soil of acid reaction. Consequently, drainage of wet soils and an application of one or two tons per acre of slaked lime or finely ground lime stone to sour soils often proves necessary to the successful growth of legumes. Neither the litmus test nor a chemical analysis of the soil can determine the need of lime nearly as satisfactorily as a field trial of this material on a legume crop. The practice of this Station has been to apply lime or finely ground lime stone to the wheat ground previous to seeding, and note the effect upon the following clover crop. Frequently this treatment benefits the wheat, but in general the results are much more marked on the following clover crop.

COMPOSITION AND FERTILIZER VALUE OF WHEAT AND CLOVER

In Table X is shown the per cent. or number of pounds per hundred of nitrogen, phosphoric acid, and potash, in wheat and clover, and the fertilizer value of same at 15 cents per pound of nitrogen, three and one-half cents per pound of phosphoric acid, and five cents per pound of potash.

TABLE X.—Fertilizer Ingredients in Wheat and Clover

	Per cent. N (nitrogen)	Per cent. P_2O_5 (phosphoric acid)	Per cent. K_2O (potash)	Value per 100 lbs. crop
Wheat grain	1.73	.96	.35	$.310
Wheat straw	.43	.13	.74	.106
Clover seed	3.05	1.45	1.35	.576
Clover hay	2.09	.43	2.08	.432

On the basis of the above figures, wheat straw is found to have a fertilizer value of $2.12 per ton and clover hay a fertilizer value of $8.64 per ton, leaving entirely out of consideration their humus forming value.

TABLE XI.—Amount of Plant Food Removed by a Twenty Bushel Crop of Wheat and Supplied by 100 Pounds of 2-8-4 Fertilizer[1]

	Pounds N (nitrogen)	Pounds P_2O_5 (phosphoric acid)	Pounds K_2O (potash)
Removed			
Grain	20.76	11.52	4.20
Straw	10.32	3.12	17.76
Total	31.08	14.64	21.96
Supplied by 100 lbs. 2-8-4 fertilizer	2.00	8.00	4.00
Deficiency	29.08	6.64	17.96

[1] Fertilizer containing two per cent. nitrogen, eight per cent. phosphoric acid and four per cent. potash

This plant food deficiency must be supplied sooner or later. Legumes will supply the necessary nitrogen. The deficiency of phosphoric acid must be supplied by using more fertilizer per acre. The potash can be supplied to a large extent if the straw is returned in manure to the land. However, on a great many Indiana soils it will be found very profitable to double the amount of potash used in the fertilizer.

PLACE FOR FERTILIZER IN THE ROTATION

In fertilizing a corn—wheat—clover rotation, the clover should be turned under for the corn, which should also be given the benefit of most of the barnyard manure available. The wheat, on the other hand, should receive a liberal application of commercial fertilizer which will also benefit the clover. If serious difficulty is encountered in securing a stand of clover, the wheat may also be given a top dressing of four or five tons of manure per acre. This will often insure a stand of clover where it is otherwise very difficult to secure the same.

One reason for giving the corn the benefit of the clover and most of the manure is that corn is growing during the entire summer and is thus able to use such material to better advantage than wheat, which stops growing early in the summer. Before the nitrogen in clover or manure can be used by corn or wheat, it must first be changed into the form of nitrates by bacteria in the soil. This change takes place during the hot weather of the summer and unless some crop is actively growing on the soil as the nitrates are formed, they are washed out and lost. Fortunately, phosphoric acid and potash are not subject to serious loss by leaching.

It pays better to use heavy applications of readily available commercial fertilizer on wheat than on corn, because only one-half to one-third as much plant food is required to produce a crop of wheat as to produce a crop of corn, and the fertilizer is consequently of proportionately greater influence on the wheat. Furthermore, as wheat makes the principal part of its growth during a comparatively short period, it must have an abundant supply of readily available food present at that time.



Fig. 5. Effect of wheat fertilizer recommended by Experiment Station, Montgomery county. Plat in center unfertilized; others fertilized

KIND OF FERTILIZER RECOMMENDED FOR WHEAT

The Station recommends for wheat the application at seeding time of about 300 pounds per acre of a fertilizer containing two per cent. nitrogen, eight per cent. available phosphoric acid and two to four per cent. potash. Fertilizer can best be applied to wheat by using a drill with fertilizer attachment. The above formula is one that can be obtained from almost all fertilizer companies.

If the farmer wishes to mix his own fertilizer and thus save several dollars per ton, the Station recommends the use of 200 pounds per acre of the following mixture: 900 pounds steamed bone meal, 900 pounds high grade acid phosphate and 200 pounds muriate of potash. These materials can be purchased from practically all fertilizer companies and can be easily mixed with a shovel on the barn floor. This mixture makes a considerably higher grade fertilizer than the 2-8-2 formula mentioned above; hence less is required.

When clover has been turned under for corn and the wheat follows the corn, there is quite often not enough nitrogen in the above fertilizers for the best results. A farmer should in this case use more nitrogen in his fertilizer or better still, top dress his wheat in the spring with 50 to 100 pounds per acre of nitrate of soda.

REDUCTION IN YIELD OF WHEAT OFTEN DUE TO DISTINCT DISEASES

F. D. Kern, Associate Botanist

The rotting of fruit, the spotting of leaves, the wilting of vines and blighting of twigs are rather familiar sights and the results are enormous annual losses to the farmers and fruit-growers. In addition to these maladies, which are rather easily observed, some crops are attacked by diseases which are often not noticeable, but which are often very injurious. The wheat crop is subject to the ravages of several diseases, some of which are well known and some which are not conspicuous and therefore often overlooked.

There are in general *three* ways in which the diseases of wheat may cause a reduction in the yield. In the *first* place, the parasite which is the cause of the disease may completely destroy the kernels in the heads and substitute in place of them its own reproductive parts or spores. The smuts work this sort of an injury. In such a case the loss is complete, for each stalk which is affected produces no wheat at all. In the *second* instance, the parasite may attack the stalk, leaves or even the head, and still permit the kernels to form; but it may so absorb the nourishment that it will cause the kernels to be small, shriveled, and light in weight. Scab, anthracnose, and rusts are examples of diseases which produce this sort of result. The *third* way in which loss may be sustained is by an aggressive attack which may result in the death of the plant. The scab disease sometimes behaves in this way.

The efforts of the investigators have not yet succeeded in working out methods which will control or prevent all of the diseases to which the wheat plant is subject. The investigations of the Botanical Department of this station, as well as experiments in neighboring states, however, all emphasize the importance of treating the seed wheat with some disinfectant, preferably *formalin*. Seed treatment with formalin will absolutely prevent the occurrence of "stinking-smut" or bunt, as it is often called, and will greatly assist in checking scab, anthracnose and other parasitic fungi. For these reasons the practice of cleaning the seed with the formalin treatment is especially urged and the essential details are here given.

SEED TREATMENT WITH FORMALIN[1]

Spread out the seed on a floor or canvas and sprinkle with a solution of one pound (about one pint) of formalin to 50 gallons of water until thoroughly moist, but not wet enough to pack in the hand. Shovel over repeatedly to distribute the moisture evenly, then shovel into a pile and cover with sacks or canvas for at least two hours. The seed may then be sown at once or may stand until the next day. If to be kept longer, grain should be dried as rapidly as possible by spreading in a thin layer and stirring occasionally with a rake. Avoid reinoculating with smut from smutty sacks or bins after treatment. The solution may be mixed in a barrel and applied with a sprinkling can. Each gallon of this solution is enough for almost two bushels of wheat.

STINKING SMUT OF WHEAT

That stinking smut of wheat occurs in abundance in Indiana is shown by the records which the Botanical Department has been keeping for a number of years. Where the disease occurs it is usually very destructive, often destroying half or more of the crop and rendering the remainder almost worthless, owing to the fact that the portion which is sound is always "docked" on the market. It is therefore doubly important to give special attention to keeping this smut from the crop, or eradicating it if it is present.

The stinking smut of wheat is caused by a parasitic fungus which is carried over from one season to another by spores attached to the kernels of the seed grain and sown with them. The fungus grows up within the tissues of the wheat plant and when the latter heads out the parasite enters the young kernels and transforms the contents into a dark brown, dust-like, somewhat greasy, ill-smelling mass, the spores of the fungus. The disagreeable odor is sometimes noticeable at harvest time and is likely to be especially noticeable at threshing time. The chaff is not attacked and on that account there is not much in appearance to indicate the presence of the fungus. The accompanying illustration (Fig. 6) shows that in general a smutted head looks very similar to a sound one. It is important to know this because many people think that no stinking

[1]Formalin is a trade name for a solution of formaldehyde gas in water. The standard strength is 40 per cent., which should be insisted upon in purchasing, because a weaker solution may not be effective. Formalin, sometimes called formaldehyde, may be procured or ordered at any drug store. The price varies somewhat but is usually to be had at from 30 to 50 cents per pound. In the local market at LaFayette "40 per cent. Formaldehyde, Merk," which is a good standard grade, may be had in one pound cans at 40 cents each. Buying in original sealed packages in this way makes it certain that it has not been diluted. Bottles or cans containing the liquid should be kept well corked to prevent the gas from escaping, which would weaken the strength. Formalin should be practically as clear as pure water; when it is at all milky it is worthless

smut is present because they detect nothing unusual in appearance. A closer examination, however, shows that there is a difference even in appearance between smutted kernels and sound ones. The smutted kernels are shorter, often being nearly spherical, and do not have the characteristic crease on one side. (Fig. 7). The smutted kernels are not hard and plump but can be crushed between the fingers and the brown, greasy powder then gives off its offensive odor.



Fig. 6. **a, Head of wheat entirely destroyed by stinking smut**
b, Sound head of wheat
(Both heads of natural size)

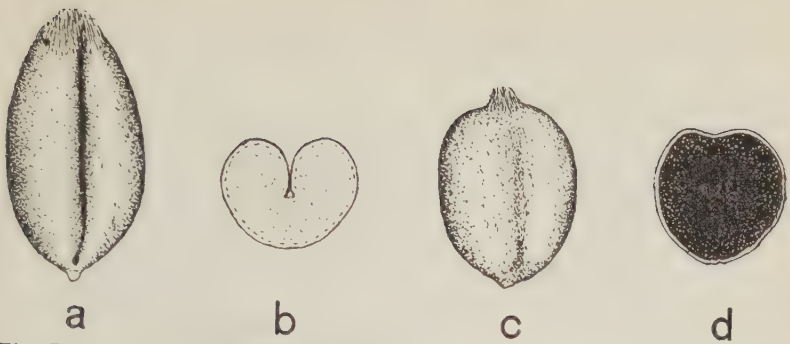


Fig. 7. **a, Sound kernel of wheat**
b, Cross section of sound kernel of wheat showing plumpness, starchy contents, and characteristic crease
c, Smutted kernel or "smut ball"
d, Cross section of smutted kernel showing crease no longer present. Contents entirely transformed to a dark brown mass of spores of the stinking smut
(All four figures are enlarged five diameters)

PREVENTION OF STINKING SMUT

The formalin treatment as outlined above is entirely successful in preventing this disease and no further comment is needed here.

SCAB OF WHEAT

There is considerable loss each year from a disease which is popularly known as "wheat scab." Heads which are affected with this trouble are covered with a pinkish, moldy coat. This covering is the fungus which causes the disease. While the scab-fungus resembles the smut-fungus in a general way it has some essential differences.

The scab undoubtedly lives over from one season to another, both as an internal infection in the kernel and by spores which cling to the outside of the kernel. The parasite is without doubt distributed from one region to another by the spores which cling to the kernels. The kernels which are internally infected may or may not germinate. If they do germinate the fungus is likely to start into such vigorous growth that the plant will be killed while still a seedling. From the roots of these dying seedlings infection may be passed on to the heads of adjoining plants at flowering time. Infection of the heads causes the familiar prematurely ripened appearance followed by the growth of the pink covering. The kernels become shriveled and very light in weight and at the same time are infected so that they will carry the disease over to the next season.

PREVENTION OF SCAB

Owing to the difference in the nature of the fungus it cannot be hoped that the formalin treatment will be as effective against scab as it is against stinking smut. It will, however, kill all spores clinging to the kernels and thus assist in preventing distribution. The scab can be further controlled by a very thorough grading of the seed because of the lightness of the scab-infected kernels. Careful observations have shown that the scabby kernels only weigh about one-half as much as the sound kernels. This shows at once the possibility of removing diseased kernels by the fanning mill process. Too much emphasis cannot be placed on the value of cleaning and recleaning the seed for the purpose of removing the light, internally infected kernels.

ANTHRACNOSE OF WHEAT

Recent investigations at the Ohio Experiment Station have proved that a premature ripening of wheat and much shriveling of the kernels is caused by a fungous parasite which has become known as anthracnose. The fungus attacks the lower portions of the stems and leaf-sheaths producing a blackened appearance of the attacked parts.

PREVENTION OF ANTHRACNOSE

The spores of this new disease cling to the seed in the same way that smut spores do and are distributed in that manner. The seed treatment already described will kill the spores and will thus prevent infection from the seed and is therefore strongly recommended.

RUST OF WHEAT

More or less damage to the wheat crop is caused each year by rust. There occur in this state both the *stem* rust and the *leaf* rust, which are two distinct species of fungi. The *stem* rust is also often called *black* rust, though it is not black throughout the season, the black color being characteristic of the last of the season only. It generally confines its activity to the stem, however, and owing to its vigorous manner of attacking the tissues and taking up nourishment, is the rust which causes the heavy losses most seasons.

PREVENTION OF RUST

No remedy or control has yet been perfected for the rust diseases and yet it is entirely possible to materially lessen the attacks from rust by giving sufficient attention to certain conditions in the culture of the crop. Whatever is done to produce a firm, strong growth of straw and to insure ample circulation of air between the stalks all the way to the ground is a virtual fighting of rust or any other leaf or stem disease, and this must be largely accomplished by methods of culture. Since rust is a disease which can be held in check only by means of cultivation of a proper sort, it may be worth while to mention a few things which should have especial attention.

Drainage is an important factor in the general health of field crops and has an influence on the amount of rust in wheat and other cereal crops. Proper drainage of the fields will greatly lessen the liability of rust epidemics.

Early ripening is a factor which is worthy of much attention in regard to grain rusts. Repeated observations go to show that anything which will shorten the vegetative period and produce early ripening is an advantage in decreasing the amount of damage from rust. Early ripening may possibly be brought about by the use of a soluble phosphate fertilizer, an early variety, or early seeding.

Clean seed on *clean land* is especially desirable. The presence of weeds in a growing crop always makes it more liable to rust attacks. They hold the moisture from showers and dew and by this means furnish better conditions for the growth of rust and infection of the straw.

Destruction of all *volunteer growths* of wheat and mowing of all *wild grasses* in the vicinity of the wheat field will also tend to prevent the perpetuation of wheat rust from outside sources.

Other points about cultivation might be mentioned, but since they embrace only the points which should have attention even if there were no diseases, they will receive their share of attention elsewhere. Perhaps enough has been said to emphasize the idea that the control of such diseases as rust, must, for the present, be looked for along the line of proper soil cultivation and drainage, and care in the cleaning and selection of seed.

LOOSE SMUT OF WHEAT

The loose smut of wheat is quite different from the stinking smut both in appearance and nature. It destroys practically the entire head, changing kernels and glumes to a mass of odorless

black spores. These spores blow away leaving only the bare spike at harvest time. The spores blow into the sound heads at flowering time and infect the young immature kernels and the disease is carried over from one year to the next as an internal infection in the apparently sound grains.

PREVENTION OF LOOSE SMUT

The formalin treatment as recommended for stinking smut cannot be used with success to prevent loose smut of wheat. No efficient and entirely safe remedy has yet been developed for loose smut. A modified hot water treatment of the seed wheat has been tried with some success and is recommended in a recent bulletin of the U. S. Department of Agriculture, Bureau of Plant Industry, No. 152. It is hoped that some form of this hot water treatment may eventually prove efficient and practicable, but at present it has not been sufficiently developed and improved so that it can be employed without considerably injuring the germination of the seed wheat. This means that an extra amount of seed must be used per acre making the method rather expensive. It seems, however, that the method is deserving of some consideration since the smut is often the source of heavy losses. Briefly, the treatment is as follows: "Soak the seed wheat in ordinary cold water for five hours, soak in hot water for ten minutes at a temperature of 54° C., or 129.2° F." Care must be taken that the hot water be not above the temperature given and the soaking be not continued longer than indicated, or the damage to the wheat may be very serious.

THE IMPORTANCE OF TREATING THE SEED

From the foregoing it will be evident that the treatment of all seed wheat, in some thorough manner, such as the formalin method is a very important factor in keeping down parasitic fungous diseases. The presence of spores of a parasitic disease in the seed wheat is just as much an adulteration as the presence of weed seeds and ought to be so regarded. Dealers ought to see to it that the seed which they offer for sale has been freed from such dangerous parasites. The cultivator must see to it that his bins and implements are disinfected with the formalin drench so that clean seed will not become contaminated in handling. If one would have healthy wheat it is just as important to keep seed from exposure to infection as it is to keep animals away from sources of infectious diseases.

THREE ENEMIES OF WHEAT

W. J. Phillips, Entomologist[1]

The loss that comes to the wheat growers each year from insect attack is very great. Thousands of dollars are lost to Indiana farmers annually from this cause. Frequently they do not notice a toll of a few bushels to the acre, probably attributing the loss to climatic or soil conditions, when in reality it is largely due to insect depredations. It is therefore very important that the farmers should know something of the life history of these pests and practical methods of control.

Of the many injurious insects affecting wheat, three, Hessian fly, joint-worm and the greater wheat-stem maggot, are doing considerable injury throughout the state at the present time. Therefore, these only will be dealt with in this article.

THE HESSIAN FLY

Mayetiola (Cecidomyia) destructor, Say

The adult insect (Fig. 8, male, Fig. 9, female) is a small, almost black, two-winged fly, resembling the mosquito very closely and of about the same size. They remain close to the ground as a rule and in the fall, when they are very abundant, may be seen depositing their little pink eggs in the grooves of the upper surfaces of the leaves.



Fig. 8. Hessian fly (Mayetiola destructor): adult male, much enlarged (Webster, Circular No. 70, Bureau of Entomology, U. S. Department of Agriculture)



Fig. 9. The Hessian fly: adult, female, much enlarged (Marlatt, Farmers' Bulletin No. 132, Bureau of Entomology, U. S. Department of Agriculture

[1] Detailed by U. S. Department of Agriculture—Cereal and Forage Crop Insect Investigations

The egg is very minute, cylindrical, with rounded ends, smooth and glossy and of a pinkish tinge, the color deepening with age.

The larva (Fig. 10) is pinkish when first hatched, changing to a whitish as it increases in size until, when nearly full grown, it attains a beautiful greenish-white tinge.

The "flaxseed" (Fig. 11) is the resting stage. The larva has now reached maturity and is encased in a brownish, leathery covering, resembling somewhat a flaxseed, from which it takes its name. This will be found at the base of the plant in the fall. (See Fig. 12)



Fig. 10. The Hessian fly: larva before flaxseed is formed, much enlarged (Webster, Circular No. 70, Bureau of Entomology, U. S. Department of Agriculture)



Fig. 11. The Hessian fly: "flaxseed" much enlarged (Webster, Circular No. 70, Bureau of Entomology, U. S. Department of Agriculture)

LIFE HISTORY

There are but two main generations during the year, one in the spring and the other in the fall. The flaxseed remains in the stubble after the wheat is cut, and adults issue in September and deposit their eggs on the young plants, the larvae working their way down into the leaf sheath, in which place they remain over winter, chiefly in the flaxseed.

EFFECT OF LARVA ON THE PLANT

In the fall, soon after infestation, the effect upon the plant becomes apparent. The infested plant has no central shoot, is a much deeper shade of green, is more stocky and the leaves stand nearly upright. These plants finally die during the winter. The uninfested plant is slender, bears a central shoot and the leaves are inclined to droop. Figs. 12 and 13 are a comparison of infested and uninfested plants.



Fig. 12. Infested wheat plant, showing the flaxseed at base. Note manner of growth as compared with Fig. 13. (Webster, Circular No. 70, Bureau of Entomology, U. S. Department of Agriculture)

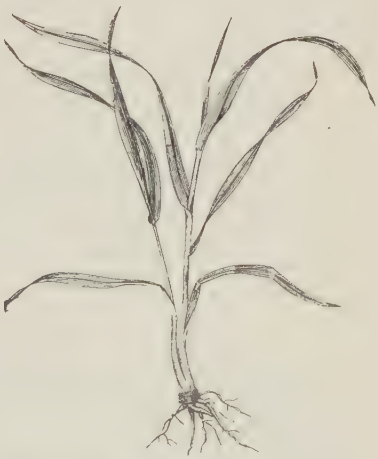


Fig. 13. Healthy wheat plant. Note manner of growth (Webster, Circular No. 70, Bureau of Entomology, U. S. Department of Agriculture)

The spring generation locates itself near a joint, weakens the stem and causes the plant to fall before harvest. A large amount of the wheat from these plants passes through as screenings.

LATE SOWING AS A MEANS OF COMBATING THE FLY

Nothing can be done if a field once becomes badly infested with the fly, though heavy fertilization or manuring will greatly assist the plants to resist the attack. It is best, therefore, when a serious attack is anticipated, to forestall it by late sowing.

From observations carried on by the Bureau of Entomology, under the direction of Professor Webster, it has been learned that wheat sown about September 20, in the northern part of Indiana; after September 25, in the central, and about October 5, in the southern part will apparently be free from Hessian fly attack. If all farmers would follow this rule there would be little or no trouble from the fly.

It is impossible to establish any fixed lines for dividing the state, but for convenience we may assume that the northern section extends as far south as Logansport; the central to Indianapolis, and the southern for all points south of Indianapolis.

Any farmer may establish a safe date of sowing for his locality by noting the time of seeding and the degree of infestation for a few years.

JOINT-WORM

(Isosoma tritici, Fitch)

The adult insect (Fig. 14) is a small, black, four-winged individual that somewhat resembles a winged ant. It is about an eighth of an inch long. The entire insect is black except the joints of the legs and the feet, which are yellow. The grub is footless, whitish and about an eighth of an inch long, with brownish jaws.



Fig. 14. Adult of the joint worm (Isosoma tritici) much enlarged (Howard, Technical Series No. 2, Bureau of Entomology, U. S. Department of Agriculture)

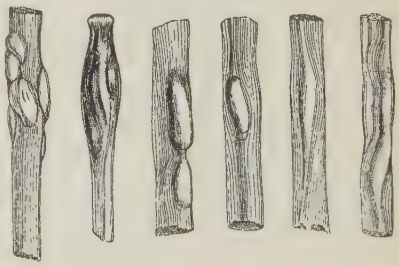


Fig. 15. Pieces of straw as they came through the thresher containing grubs of the joint-worm (Webster, Circular No. 66, Bureau of Entomology, U. S. Department of Agriculture)

LIFE HISTORY

The entire life history is spent within the walls of the stem. In the spring the larva changes to a pupa and this in turn soon changes to an adult, which gnaws a tiny hole in the stem and emerges. There is but one generation of this species a year.

EFFECT ON THE PLANT

The stems often present a warty and knotted appearance, as shown in Fig. 15, causing them to bend and break and recline upon the ground, thus interfering with the flow of sap. Upon opening one of these knots or galls a small grub will be found.

Fig. 16 is a comparison of yield from 100 healthy stems and the same number infested.

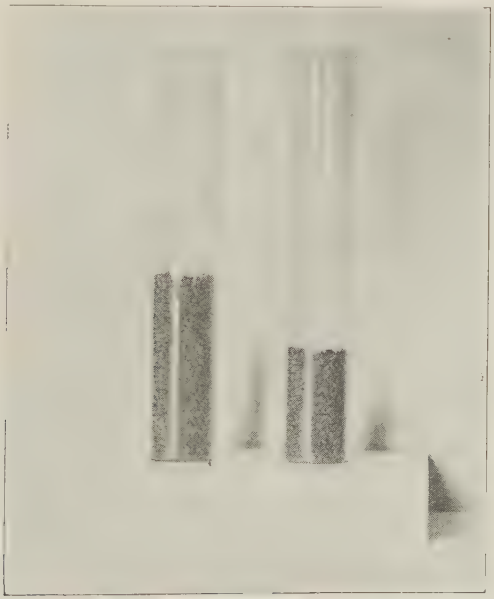


Fig. 16. Cylinder to left represents yield of 100 healthy plants and the one on the right the yield of same number of plants infested with the joint-worm (from Webster)

REMEDIAL AND PREVENTIVE MEASURES

There is no remedy, once a field becomes badly infested with this pest, though heavy fertilization will somewhat strengthen the plants and help them to resist the attack.

The joint-worm is not easily controlled, as the farmer usually sows clover with his wheat. The most effective means of combating the pest, when clover is sown with the wheat, is burning over the old stubble fields. This should be done during a dry period in the winter when the ground is frozen. A large part of the stubble will then burn off, thus destroying the greater portion of the joint-worm larvae, and causing little or no damage to the clover. Where clover does not follow, mow the stubble down close, disk thoroughly, and plow under deep just after harvest. The stems will then decay and the grubs die. Prepare the seed-bed carefully and manure with well composted barnyard manure or fertilize heavily; this will cause a vigorous growth and in a great measure help the plants to outgrow the effects of the attack. It is also advantageous to sow early maturing varieties.

THE GREATER WHEAT STEM-MAGGOT

(Meromyza Americana, Fitch)

The adult insect is a small, two-winged fly of a pale greenish color, with three dark stripes down its back; it is a little over one-eighth of an inch long.

The egg is spindle-shaped, white, very small and inconspicuous.

The larva is a long, slender, footless grub, of a greenish white to a pale green color. When fully grown it is a quarter of an inch long and about one-eighth inch thick.

LIFE HISTORY

There appears to be three generations of this insect during the year, one in the spring, a second in the summer and a third in the autumn. They pass the winter as grubs in the dead plants, issuing as adults some time in May. The adults of the second generation appear the latter part of June and up into July, the third generation of adults appearing in August and September.

EFFECT OF THE LARVA ON THE PLANT

The spring and fall generations are the only ones that do any appreciable injury; the summer generation attacking only volunteer grain and the grasses, chiefly the latter. During September the adult flies deposit their eggs in and upon the young wheat plants. Upon hatching, the young grubs work their way down into the central shoot of the plant and destroy it. Their presence is indicated by this central shoot turning a yellowish brown color and dying. A large number of the plants so attacked die before they have an opportunity

to tiller out. In the spring the full grown larva changes to a pupa, the adults issuing some time in May. The grubs of this generation work in the top joint of the wheat plant and cut off the tender stem at this point, causing the wheat head to turn almost white, and preventing the development of the grain.

PREVENTIVE MEASURES

The same recommendations that appear on pages 35 and 36 will apply for this insect, with the additional precautions of destroying all volunteer grains and the common grasses, such as infest all waste places.



Fig. 17. A good field of wheat

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 24

LaFayette, Ind., July, 1910

AGRICULTURAL EXTENSION
VIII

INFORMATION ON WORK OF PURDUE EXPERIMENT STATION AND SCHOOL OF AGRICULTURE

The field occupied and the amount of work accomplished by the Purdue University Agricultural Experiment Station and School of Agriculture, is increasing rapidly each year. Increased funds and equipment have allowed the men in charge to attack the agricultural problems in an extensive and thorough way, thus enabling them to secure much interesting and valuable data. Results of and information concerning the various lines of work have been published in bulletins and circulars.

The number of each bulletin and circular printed and distributed in the state has been small compared with the total number of farmers and others directly interested in agriculture. The number has been limited because of a lack of funds and for the further reason that all people are not interested in all the subjects treated. It is therefore deemed advisable to have parties acquaint themselves with the work of the departments and apply for bulletins and circulars in which they are directly interested.

To supply the general information relative to the Experiment Station and School of Agriculture, this circular has been prepared. In it will be found a brief outline of the work of the various departments with the name and number of recent publications available for distribution.

Persons interested in further details of the work mentioned should write for bulletins and circulars.



Fig. 1. The new Purdue live stock judging pavilion

PURDUE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION

ARTHUR GOSS, Director

The Agricultural Experiment Station was organized in 1887, under the act of Congress known as the Hatch Act. It employs a staff of scientists, skilled in agronomy, animal husbandry, dairying, horticulture, botany, chemistry and veterinary science. These workers are engaged in collecting scientific facts and truths applying to agriculture, preparing bulletins and answering correspondence. Further support was given to this work through the passage of the Adams Act by Congress in 1906.

Through the act of the Indiana State Legislature of 1905 the Station was enabled to take up new lines of investigational work and to establish a department of agricultural extension. Already much work has been accomplished through cooperative experiments in soils, field crops and horticulture, extensive cattle feeding experiments, herd tests, county experiment stations, special educational trains, fair exhibits, district short courses, newspaper articles and addresses made by the workers at the various state and county meetings of the agricultural organizations.

To advance the lines of work of the Experiment Station already under way and to meet the urgent demands for information on new problems, the State Legislature of 1909 increased the Station maintenance fund to $75,000 per annum. Of this amount, $15,000 are used for soil and crop improvement; $10,000 for dairying; $10,000 for animal husbandry; $5,000 for poultry; $10,000 for horticulture; $5,000 for hog cholera and other animal diseases; $10,000 for agricultural extension and $10,000 for general expenses.

In addition to the investigational and extension work, the Experiment Station administers through the office of the State Chemist, the Fertilizer Control Law passed in 1901 and the Stock Food Control Law passed in 1907 by the Indiana State Legislature.

In these ways the Station has become a source of definite information and helpfulness for the entire agricultural class of the state.

AGRICULTURAL EXTENSION DEPARTMENT

G. I. Christie G. M. Frier Helen H. Henry

The work of the Agricultural Extension Department consists in promoting schemes that carry to the people of the state information relative to the work of the Experiment Station, School of Agriculture and agriculture in general. The object of this work is to reach in a direct way people remote from the institution and to acquaint them with the best and most up to date information on agriculture.

The most important of the lines of work carried on are as follows:

DISTRICT SHORT COURSES

The District Farmers' Short Course is an outgrowth of the Annual State Farmers' Short Course held at Purdue. It is the result of a demand on the part of the people for advanced practical agricultural instruction to be given at points in the state conveniently located and easily accessible.

During the past year courses of one week each were given in the first, sixth and ninth congressional districts. Instruction in crops, soils, animal husbandry, horticulture, dairying, poultry and domestic science was given by representatives of the various departments of the Station and School. The work consisted of practical judging, demonstrations and lectures and was of great value and helpfulness to all.

The interest taken in this work is shown in a measure by the large attendance.

District	Town	Attendance
First	Evansville	2137
Sixth	Greensburg	776
Ninth	Veedersburg	444

During the coming year courses will be held at Evansville, Terre Haute, Richmond, Muncie, Huntington and South Bend. Large towns with good railway facilities and ample accommodations in the way of buildings have been chosen because of the large number of people who desire to attend these courses.

SMALL SEED IMPROVEMENT

In cooperation with the Bureau of Plant Industry of the U. S. Department of Agriculture the Experiment Station has established a Branch Seed Laboratory. This laboratory furnishes an opportunity for any one, either farmer or seedsman, to submit samples of seed of agricultural crops including clover, alfalfa and grasses for examination as to the presence of obnoxious or other weed

seeds, chaff or dirt. Samples of seed submitted are also tested for germination. The reports on samples analyzed give the per cent. of pure seed, inert matter and foreign seed, the names of weed seeds found with the approximate number of seeds of each in one pound of the sample and per cent. of germination. With this data the farmer or seedsman is in a position to decide as to whether or not he wishes the seed in question.

The seeds of clovers and grasses furnish a medium through which many obnoxious weeds gain access to the farms of the state, and farmers should exercise every care in selecting seed. The Department of Extension will analyze, test and report free all samples submitted.

Up to June 1, 685 samples have been examined at the laboratory, showing a general interest in the improvement of the crop seeds.

FAIR EXHIBITS

During the fall of 1909 exhibits were made at the county fairs held at Hagerstown, Newtown, LaFayette, Crawfordsville, Converse, Rushville, Muncie and Middletown, at the Indiana State Fair and at the National Corn Exposition. These exhibits consisted of a graphic display of the work of the Experiment Station and School

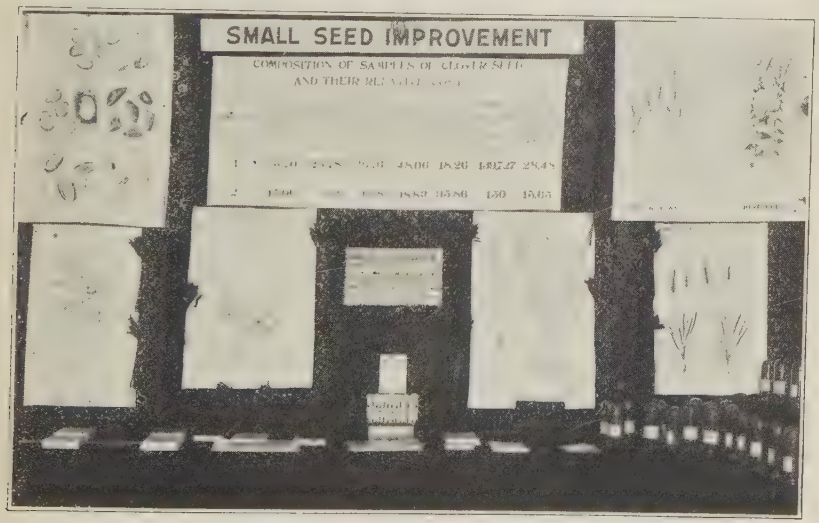


Fig. 2. An exhibit of small seed improvement work

of Agriculture. The exhibit materials consisted of grains, fruits, spraying materials, pictures, bromides, charts, weeds, seeds, etc. Representatives of the Station and School accompanied the exhibits and explained the work to visitors. In this way the exhibits were directly educational and were much appreciated by the people. The attendance at the county fairs alone was more than 127,000. This year exhibits will be made at 20 county fairs and the Indiana State Fair.

YOUNG PEOPLE'S CONTESTS

The Department of Extension in cooperation with the Farmers' Institutes is assisting in the organization of young people's contests. At present more than 50 counties are organized with about 12,000 boys and girls.

The work consists of corn growing, bread making, sewing, fruit canning, etc. At a show held in the fall each member will exhibit products of the season's work together with a write-up of how the work was done.

These contests are popular and are doing much to interest the young people in the movement for a better agriculture and a better home life.

RURAL SCHOOL AGRICULTURE

At the present time there is a strong demand for information on methods of teaching agriculture in the rural schools of the state. To assist in this movement and to be of helpfulness to the school teachers, the Extension Department has carried on some work. At each district farmers' short course a two days course was given for school teachers. In this course methods of teaching agriculture were demonstrated, the subjects of corn judging, weed seed identification, horticulture and domestic science being taken up. More than 450 teachers were enrolled in these courses and it is felt that much was accomplished for the teaching of agriculture.

At this time the Department is preparing collections of weed seeds, which are to be distributed among the teachers of the state for their use in class work. These collections consist of 35 common weed seeds and will aid the teachers in the identification of weed seeds brought in by pupils. A small fee to cover cost of preparation is charged for this collection. Anyone wishing same should apply to the Extension Department.

HORTICULTURAL DEMONSTRATIONS

The Departments of Horticulture and Extension have cooperated in holding demonstration meetings at various points in the state. At these meetings practical demonstrations in the making of spray mixtures, applying same, pruning of trees, etc., were made. On these occasions lectures on location of orchards, management of

orchards, control of insects and plant diseases were also given. These demonstrations have proved popular and have done much to arouse interest in the subject of fruit growing.

During the coming fall similar meetings will be held in the state. Those interested should apply for information relative to the holding of these meetings.

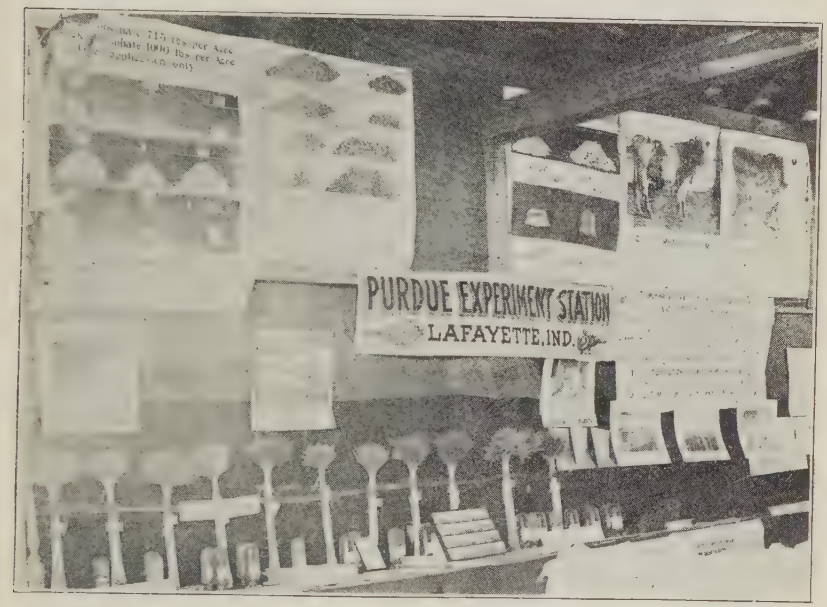


Fig. 3. One corner of a County Fair exhibit

LIVE STOCK JUDGING CONTESTS

A recent circular has been issued by the Departments of Animal Husbandry and Extension on Live Stock Judging Contests at County Fairs. In this circular the plan for stock judging contests is set forth and the county fairs are urged to inaugurate a contest. Already more than 10 county fair contests have been arranged. The Extension Department furnishes a judge for these contests while the fair management supplies the premiums. The object of these contests is to interest the young people in live stock and at the same time direct their attention towards the state judging contest at the Indiana State Fair where $500 is offered in premiums, in the form of scholarships in the Purdue School of Agriculture.

Last year 20 boys took part in this state contest and this year, it is hoped that more than 100 will compete. Any one interested in these contests should apply for information.



Fig. 4. Farmers inspecting cows on Erie dairy train



Fig. 5. Inspecting cattle at recent Cattle Feeders' convention

AGRONOMY DEPARTMENT

A. T. Wiancko M. L. Fisher C. O. Cromer

The ultimate object of the work of this Department is to bring about improvements in field crop production by testing and introducing improved varieties and valuable new crops throughout the state, by improving the best existing varieties or strains through systematic breeding, by studying soil preparation and general cultural methods, systems of cropping and crop rotation, etc.

The following are some of the more important lines of work in progress:



Fig. 6. Threshing varieties on the Station farm with a small-size separator run by a gasoline engine

1. Testing the value of new and promising varieties of all kinds of grain and forage crops of interest to Indiana agriculture.

2. The improvement of the leading farm crops by systematic breeding and selection, including studies of methods. The corn breeding plots are located in different parts of the state with the object of producing, in each case, a type of corn particularly suited to that locality.

3. Studies of the relative productiveness of several different types of seed ears selected from the same variety of corn.

4. A study of the relative value of lots of seed corn selected at different stages of maturity.

5. A study of the longevity of various farm seeds when stored under ordinary farm conditions.

6. Studies of the relative merits of various corn cultural implements, and various systems of corn cultivation.

7. Studies of the relative merits of various systems of crop rotation on three different soil types.

8. Testing different rates of seeding, distance and methods of sowing soy beans and cow peas.

9. Experiments to determine the adaptability of alfalfa to various conditions throughout the state, and the relative merits of summer and early fall sowing of alfalfa, with and without the application of lime. Over 100 such experiments are under way and some are located in nearly every county of the state.



Fig. 7. Harvesting broom corn varieties. Yields range from 500 pounds to 1000 pounds per acre

10. Cooperative tests of leading varieties of corn, oats, wheat, cow peas and soy beans. These tests include from four to five of the leading varieties of each crop, and are distributed as uniformly as possible throughout the state, from six to a dozen or more being located in each county. The total number of such tests going on this year is 782.

Publications. Among the recent publications of results of the work of the Agronomy Department are the following:

Bulletin No. 110 (revised edition) Corn Improvement.

This bulletin contains a discussion of seed corn selection, test-

ing and preparation for planting, methods of corn breeding and special seed production, with full discussion of the corn score card and its use in corn improvement. It also contains numerous photographic illustrations to aid the farmer in selecting good seed corn.

Bulletin No. 114. Winter Wheat.

This bulletin contains the results of tests of 68 varieties of wheat on the University farm from 1901 to 1906 inclusive, and includes descriptions of the varieties, discussions of their relative milling qualities, and analyses showing relative nitrogen content, and a general discussion of the best methods of wheat production.



Fig. 8. Cow peas and soy beans after wheat 1909. Cow peas in front of the man; soy beans behind him. Sowed July 10. Green weight Sept. 29: cow peas 10.8 tons per acre; soy beans 9.3 tons. In the soy beans there were 130 pounds nitrogen in the tops and 14.4 pounds in the roots, worth $18 per acre. Cow peas not analyzed

Bulletins Nos. 117, 124, 132 and 139. Results of Cooperative Tests of Varieties of Corn, Oats, Wheat, Soy Beans and Cow Peas.

These bulletins contain the results of tests of several leading varieties of each of these crops on several hundred farms throughout the state during 1906, 1907, 1908 and 1909. Bulletin No. 139 contains summaries of the results of these cooperative variety tests during the last four years.

Bulletin No. 120. Soy Beans, Cow Peas and Other Forage Crops.

This bulletin contains the results of several years' tests of

varieties, descriptions of the varieties of soy beans and cow peas tested, the result of tests of various cultural methods, the value of various forage crops for growing in succession for soiling purposes, and a general discussion of the conditions necessary to the successful production of soy beans and cow peas, both of which seem destined to become important crops in Indiana agriculture.

Bulletin No. 122. Alfalfa in Indiana.

This bulletin contains the results of experiments on about 70



Fig. 9. Using the fanning mill to improve the seed. This is one of the most effective methods of crop improvement

farms, in as many different parts of the state, to determine the adaptability of alfalfa to various soil conditions, various methods of seeding, and the best time of year to sow, with a general discussion of the value and use of alfalfa, and what is so far known concerning the conditions necessary to its successful production in Indiana.

ANIMAL HUSBANDRY DEPARTMENT

J. H. Skinner H. P. Rusk

The aim of the Animal Husbandry Department has been to study practical problems confronting Indiana farmers and answer questions of vital importance to the success of those who are handling beef cattle, hogs, and sheep. The Department is well equipped to study the different phases of this work, especially with reference to the feeding of cattle and swine. Broadly speaking, the work of this Department is of two distinct classes:

1. Experimental investigation,
2. Extension, or the dissemination of information.

EXPERIMENTAL INVESTIGATION

The Equipment consists of a storage barn, silos, feed lots, sheds, racks, troughs, and mangers, to feed 140 steers and 200 pigs at one time. The equipment for this work, while good, is not expensive, and is so arranged that the results obtained usually may be applied to conditions on Indiana farms. The cattle are fed in lots 40 x 50 feet with a 12 foot open shed on the west. The experimental pigs are fed in lots 26 x 71 feet in which there is a house 8 x 10 feet. They are fed in round bottomed metal troughs set on concrete platforms. The sheep barn is a plain barn with combination grain troughs and hay racks inside and a wide open shed facing south, on the east of the main barn.

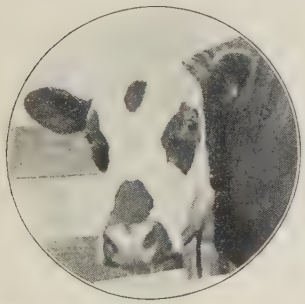


Fig. 10. A good feeder's head
Daily gain 3.44 pounds



Fig. 11. A poor feeder's head
Daily gain one pound

Cattle Feeding.—The experimental cattle feeding during the past five years has involved over 500 head of steers. The results of this work have thrown light on some of the more important problems confronting the feeder as follows:

1. The influence of age on the economy and profit of beef production.

2. The value of and extent to which silage can be used in the ration for fattening steers as measured by the rate and cost of gain, finish of the cattle, and profit.

3. The importance and value of nitrogenous concentrates as shown by the rate of gain, cost of gain, feed consumed, and profit as well as the influence on the carcass.

4. The influence of different proportions of nitrogenous concentrates in the ration for fattening cattle.

5. The relative merits of "long" and "short" feeding periods for two year old cattle.

6. The results of finishing cattle of different ages.

Publications—

Bulletin No. 115. Steer Feeding.

Bulletin No. 129. Steer Feeding II. Winter Steer Feeding 1906-7 and 1907-8.

Bulletin No. 130. Steer Feeding III. Results of Short vs. Long Feeding Periods.

Bulletin No. 136. Steer Feeding IV. Winter Steer Feeding 1908-9.

Bulletin No. 142. Steer Feeding V. Finishing Steers. (A summary of three years' work)

Part I—Dry Lot vs. Pasture for Finishing Yearlings.

Part II—Finishing Two Year Old Steers.

Part III—"Short-fed" Cattle at 1908 International.

Bulletin No. 146. Steer Feeding VI. Influence of Age on the Economy and Profit from Feeding Calves, Yearlings, and Two-year-olds. (A summary of three years' work)

Circular No. 8. Purchasing Feeders.

Circular No. 12. Methods of Beef Production in Indiana.

Circular No. 14. Factors which Influence the Value and Cost of Feeders.

Pork Production.—The work of pork production has been in progress more than 15 years and much valuable information has been obtained and disseminated in regard to experimental work with feeds, such as tankage, skim milk, butter milk, linseed oil meal, soy beans, middlings, etc.; a study of the cost of maintaining brood sows, and growing pigs in winter on different rations, has been in progress for some time.

Other problems receiving attention are—

Influence of different proportions of water to feed for growing fattening pigs, the influence of Yorkshire blood on the Poland China and Berkshire breeds, a study of bacon types of hogs, and the economy and profit of forage crops in pork production, the relative economy and profit of hominy feed as compared with corn.



Fig. 12. Experimental pig lots and houses

Publications available—

Bulletin No. 108. Soy Beans, Middlings, and Tankage as Supplements in Pork Production.

Bulletin No. 126. Supplements to Corn for Fattening Hogs in Dry Lot.

Bulletin No. 137. Dairy By-products as Supplements to Corn for Fattening Hogs.

These bulletins give the rations used, the amount of grain required to produce 100 pounds of pork, and the rate and cost of gains made by hogs under different methods of feeding and management.

Mutton Production.—This important branch of Animal Husbandry has not received the attention in the past that it merits. However, a study of maintenance rations involving dry and succulent feeds (silage) for breeding ewes in winter and the production of "hot-house lambs" has been made during the past four years.

Publications available—

Bulletin No. 147. Corn Silage for Winter Feeding of Ewes and Young Lambs.



Fig. 13. View of sheep barn showing large open shed for ewes and lambs in winter; also rape pasture for summer forage



Fig. 14. Fall lambs fed silage

EXTENSION

The dissemination of information obtained by experimental investigation is a very important phase of the work of this Department. The work along this line for some years has consisted of—

Addresses given before farmers' institutes, meetings of feeders and breeders; lectures and demonstrations given before farmers in connection with the district short courses held in the state; exhibits at state and county fairs and the International Livestock Show showing results of work at the Station; cooperative work with farmers and feeders, visits of inspection in various parts of the state in order to obtain information as to problems and conditions confronting feeders and offer suggestions when solicited as to methods of feeding and management of stock; replies to large numbers of inquiries sent in to the Department from Indiana farmers.

Cooperative Work.—The Department has been cooperating with progressive feeders who are in position to keep records of feed consumed, gains, etc., for several years and is anxious to extend this cooperative work, under suitable conditions, among such cattle, swine, and sheep feeders as are prepared to take up the work and keep records of their operations. Such cooperation is not only mutually beneficial to the farmer and the Experiment Station but helpful to the community in which such cooperative work is in progress.

The Station men are sent out to study the conditions on the farms and those wishing to cooperate, obtain information and organize cooperative experiments, weigh and note condition of the stock, feeds, etc., and make suggestions as to feeding and management, when they are desired.

Anyone wishing to take up such cooperative work should write the Department in regard to it.

The Department has also cooperated with the *Cattle Feeders' Association* in arranging for *meetings* twice a year in May and November at the University to which farmers and feeders are invited. At these meetings the experimental cattle are inspected and talks given by men from the Department, farmers who are cooperating with the station, and other prominent authorities on cattle feeding. The results of experimental work are usually discussed at the May meeting. *Farmers are cordially invited to attend these meetings.*

Correspondence.—Many inquiries are received by the Department concerning results of feeding experiments with horses, cattle, sheep, and hogs. This is one of the most valuable lines of work carried on and many farmers have taken advantage of this means of securing information from a reliable source. *Inquiries* from farmers, relating to the selection, feeding, care, and management, the use of various feeds such as corn silage, cotton-seed meal, linseed meal, tankage, gluten feed, alfalfa feeds, and forage crops, *are invited.*

BOTANICAL DEPARTMENT

J. C. Arthur — A. G. Johnson — Mary A. Fitch
F. D. Kern — Thos. Billings — Evelyn Allison

The work of the Botanical Department is devoted to the study of parasitic fungi, especially those forms which are the agents of disease in agricultural crops, to weeds and their eradication, and to wild and cultivated mushrooms. The different lines of work may be considered separately.

Parasitic Plant Diseases.—A record of the distribution and prevalence of the more common fungus diseases of cultivated crops is compiled at the close of each growing season. In this work the Department has the hearty cooperation of a large number of correspondents throughout the state. Much information regarding diseases and their preventives and treatments is sent by letters to correspondents. Observations are made each year on more than 50 kinds of parasitic diseases, 90 per cent. of which are due to fungi such as smuts, rusts and scab.

In the past some notable results have been achieved by the Department in the study of the grain smuts. The formalin method for treating the seed has been further tested and has proved very satisfactory. The process is simple and inexpensive and should be more extensively employed by those who raise wheat and oats.

The seed oats or wheat are sprinkled (See Fig. 15) until thoroughly damp with a solution made by adding one pound of 40 per cent. formalin to 50 gallons of water. They are then shoveled into a pile, (See Fig. 16) covered and allowed to stand for two hours or more, after which they are ready to sow or to be dried and kept for later sowing.

It has also been shown that this formalin method of seed treatment will assist in checking the distribution of other diseases of grain such as anthracnose and scab.

The intensive investigation of rusts of all classes of plants is still being continued. The systematic study of these minute and variable organisms is one of the most difficult known to botanical science. The rust problems are of universal importance and it is expected that the issue of a standard work of reference, such as is in preparation by this Department, will elicit and make possible the cooperation of investigators in other states which will ultimately lead to the solutions of some practical problems. Extended studies of these rust parasites are carried on each year in the greenhouses and some notable advances have been achieved by these studies.



Fig. 15. Application of the formalin solution with an ordinary sprinkling can while grain is being shoveled over



Fig. 16. Pile of grain covered; to be left thus at least two hours

Weeds.—Much attention of the Department is devoted to the study of the introduction, dissemination and destruction of weeds in the state. Many specimens of plants and weeds are received each season for identification and much information concerning means of extermination is furnished through the replies to the correspondents.

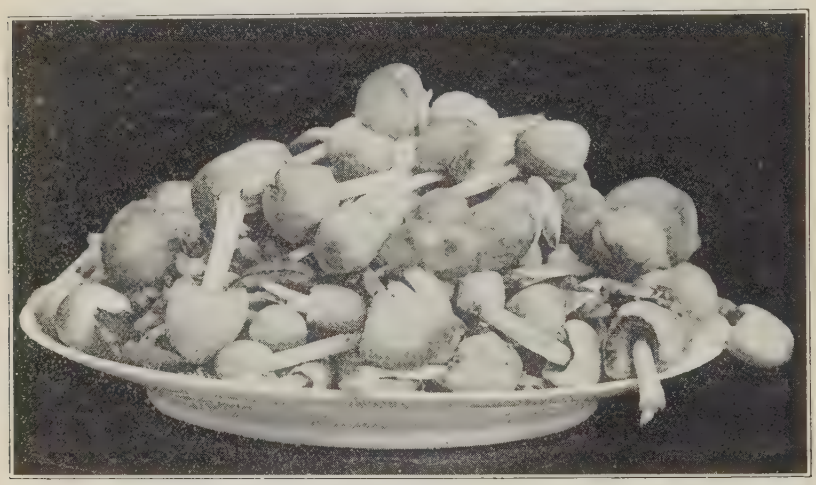


Fig. 17. A plate of tan colored mushrooms; a common edible variety often found in dense clusters at the base of living trees. These are ready to cook

Mushrooms.—Many inquiries are received each year concerning the wholesomeness of wild mushrooms and regarding the methods of cultivation. This Department is doing what it can to assist the people of the state in recognizing the more common edible forms so that they may make use of them as articles of food.

CHEMICAL DEPARTMENT

ARTHUR GOSS S. D. CONNER J. B. ABBOTT

The principal work of this Department at the present time is along the line of soil improvement. A large number of experiments with fertilizers and manure are carried on in different parts of the state on various crops and types of soil each year. The crops which have been experimented with are corn, wheat, oats, clover, timothy, potatoes, onions, tomatoes, and other vegetables and fruits. Tests have been carried to successful conclusion on all the principal soil types in Indiana. As a result of these field tests, the Station is able to suggest the fertilizer treatment required by the various crops and soils of the state. The Station does not make a practice of analyzing soil samples to determine the fertilizer requirements, as there are no chemical methods known that will accurately determine the amount of available plant food in the soil under the varying crop and climatic conditions. It is found best to use the experience obtained in the actual field test in advising methods of treating the soil. Each soil type must be studied by itself. What may be good for one soil may be of no value for another soil. One soil may need one element, another soil may need another element, while still another may need all of the fertilizer elements. Farmers wishing information concerning the fertilizer needs of their soil, should write to the Experiment Station giving a description of the type of soil, the kind of treatment it has had, the system of cropping proposed, together with any other information bearing on a particular case. The Station will then be able to advise them intelligently.

In the following illustrations are shown some of the results secured in the soil improvement work of the Station.



Bushels per acre, 15 Bushels per acre, 49 Bushels per acre, 10

Fig. 18. Experiment showing element principally needed on "bogus" soil, Jasper county

Although phosphorus when used alone or in combination with nitrogen alone, is of no benefit on this type of soil, it is nearly always found to be of benefit when used as an addition to potash. In such cases the plats having phosphorus and potash always mature sooner than where potash alone is used.



Bushels per acre, 15 Bushels per acre, 27 Bushels per acre, 37

Fig. 19. Experiment showing effect of using different amounts of potash on "bogus" soil, Jasper county

As the above illustration shows, it pays to use a good sized application of potash on this type of soil. It is almost invariably the case that the second 100 pounds of muriate of potash pay large returns. As potash remains in the soil until used, there will be large returns from the following crops as well as from the first.



Fig. 20

In Fig. 20 is shown the effect of the use of potash on black sand, sometimes called "bogus" soil in Jasper county. This is a typical test for many of the soils of that region, although it should not be understood that all soils of even this county would require exactly the same fertilizer treatment.

DAIRY HUSBANDRY DEPARTMENT

O. F. Hunziker
H. C. Mills — O. E. Reed — George Spitzer
P. Roberts — W. R. Wright — W. F. Epple

PURPOSE OF THE DEPARTMENT

To furnish information to milk producers on the economic production of sanitary milk; to assist the manufacturer of butter, cheese, ice cream and condensed milk in successfully turning out a high quality of dairy product.



Fig. 21. Comfortable and suitable quarters for the dairy sire

PLAN OF WORK

The work of this Department is divided into

1. Field work,
2. Experimental work.

FIELD WORK

Special Dairy Meetings and Institutes are conducted in all sections of the state throughout the year. Instruction is given to the dairy farmer on the selection and breeding of dairy cows; grading up, feeding, care and management of the dairy herd; care and handling of milk and cream; care and operation of the farm separator and the Babcock test; farm butter making; organization of cooperative creameries; and establishment of markets for dairy products.

Send for Circular No. 11 on "The Improvement of the Dairy Herd," Circular No. 13 on "Feeding of Dairy Cattle," Circular No. 20 on "Economic and Sanitary Milk Production."



Fig. 22. Interior of Purdue dairy barn

Visits to Dairy Farms and Creameries.—These visits make it possible for the dairyman and factoryman to receive personal advice and assistance for the solution of their local problems. In communities contemplating the establishment of cooperative creameries, the advisability of the installment of such creameries is carefully investigated and specifications for suitable buildings and equipment are furnished by the Department.

Butter-makers receive assistance in the operation of their plants, in making the proper over-run, and in the manufacture of a

high quality of butter which conforms in composition with the laws of the United States Internal Revenue Department.

Educational Butter Scoring Contests are held bi-monthly for the purpose of educating farm and factory butter-makers in the demands of the market. The butter is scored by a Government Butter Expert and the scores and criticisms are forwarded at the conclusion of each contest to the respective butter-makers. These contests are splendid opportunities for the progressive butter-maker to perfect himself in his business without expense. Every butter-maker in the state should take advantage of these contests.

Special Dairy Trains.—Whenever opportunity presents itself, special dairy trains are operated. Their purpose is, by means of talks and cow demonstrations, to stimulate interest in the economic and profitable husbandry of the dairy cow.



Fig. 23. A profitable herd of dairy cows
The Purdue dairy barn

DAIRY INVESTIGATIONS

Cooperative Herd Test Experiments are conducted with all Indiana dairymen desiring to know the annual production of milk and butter fat of their cows. Sample bottles, dippers, etc., are furnished free of charge for this work. Over 300 annual records of Indiana dairy cows have been made by the Department. The only possible way of making a herd profitable is to know the individual production of each cow. This can be done by weighing and testing the milk regularly, and then weeding out the poor cows and breeding the profitable ones to pure blood sires. Send for Bulletin No. 127.

Official Cow Tests are made by representatives of the Department for any Indiana breeder of dairy stock, who desires to have his animals try for entry in the Advanced Registry or in the Register of Merit.

Cream Testing Experiments.—An extended experimental study was made of the conditions controlling the accuracy of the cream test. It embraced such factors as accuracy and style of test bottle, method of calibration, method of sampling cream, care and preparation of the sample, details of the test, and methods of reading the test. The results of these investigations should be of special interest to the dairy farmer as well as to the creamery, for he depends on the cream test for the returns from his cream. Write for Bulletin No. 145.

Moisture Control of Butter.—Experiments have been in operation since 1907, and the work is nearing completion. Information and specific instruction that will enable the butter-maker to control the per cent. of moisture in his butter will be of inestimable value to the dairy interests of the state and country.

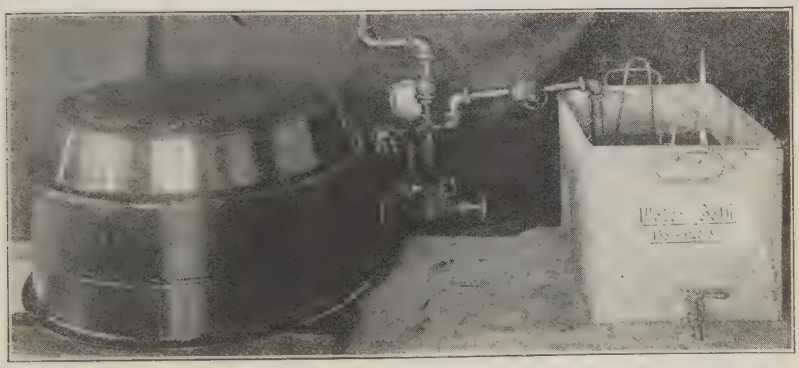


Fig. 24. The use of a water bath is indispensable for accurate cream tests

Condensed Milk Standards.—Investigations concerning condensed milk standards have been conducted since 1908. They are now complete and the results are published in Bulletin No. 143. This bulletin also contains a copy of the Federal Food and Drugs Act and information concerning the Interstate Commerce Law.

Testing Ice Cream and Sweetened Condensed Milk for Butterfat.—The rigid enforcement of the Federal Pure Food and Drugs Act makes necessary a rapid, practical and accurate method for determining the per cent. of fat contained in these dairy products.



Fig. 25. A good type of inexpensive milk house



Fig. 26. A poor type of milk house

HORTICULTURAL DEPARTMENT

J. Troop C. G. Woodbury
J. W. Wellington M. W. Richards J. G. Boyle

PURPOSE

It is the purpose of the Department of Horticulture to give assistance and advice to every fruit grower in the state who desires it, and to help each community and individual so far as possible to work out their own peculiar horticultural problems.

Owing to the special appropriation made for horticultural work by the last Legislature, the Department has been able to considerably widen its field of activity and usefulness to the people of the state.

LINES OF WORK

San Jose Scale.—The control of the San Jose scale is one of the most serious problems confronting the fruit growers of the state. For several years the Department has carried on field tests of a number of different remedies for this pest to determine what material was of the greatest value to the practical orchardist. The results of this work are summarized in Bulletin No. 138 and indicate that the lime-sulphur wash is the best and cheapest all round spray for San Jose scale. Some of the commercial brands of ready made lime-sulphur were tested and compared very favorably with the home-made material. Some of the oil sprays do efficient work, and while pleasanter to handle than lime-sulphur, are not as a class so safe nor so efficient.

THE FARMER'S ORCHARD

Much attention is being given to the saving of the home orchards of our state. These small old orchards which are so abundant in the longer settled portions of the state are certainly doomed to destruction unless speedy measures are taken for their protection. As a rule they are unpruned, uncultivated and unsprayed, and consequently unsightly and unprofitable. Many of them may be saved and made a source of profit and pleasure by intelligent care.

Circular No. 17, "The Farmer's Orchard" gives full directions for the laying out, care and management of the home orchard and discusses the problems of selection of varieties, pruning, setting, cultivation, etc., with especial reference to the general farmer. Treatments are outlined also for renovating and caring for old and neglected orchards.

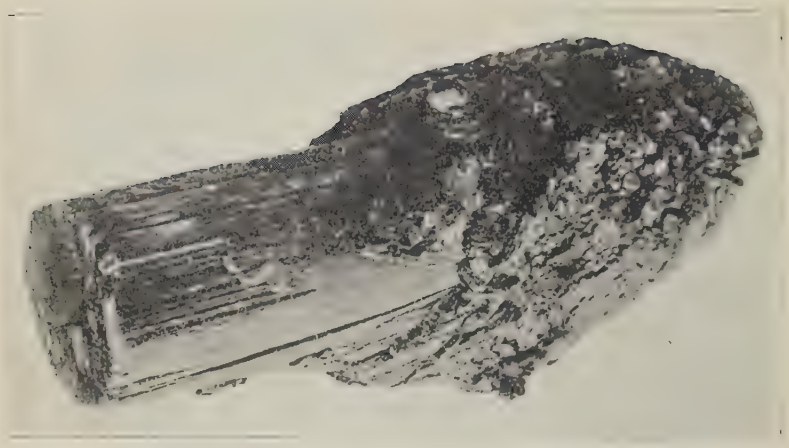


Fig. 27. An example of thoroughly bad pruning. The cut was not started on the under side, hence the limb splintered badly. The stub was left too long and could never heal (From Circular No. 17)

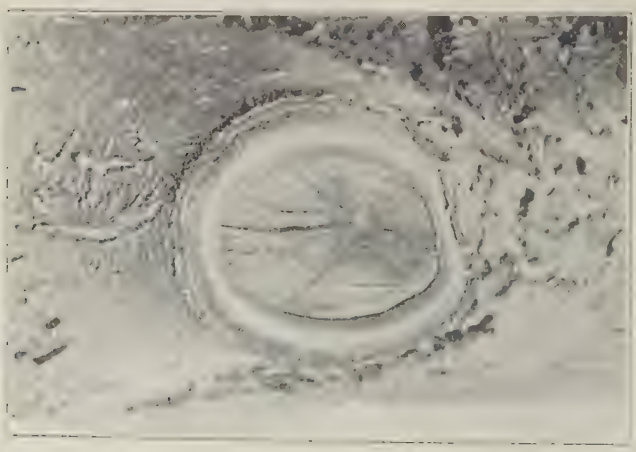


Fig. 28. This wound was properly made and is starting to heal nicely. A good coat of paint should protect the wood until covered with the callous (From Circular No. 17)

Circular No. 21, "Spraying the Orchard" is supplementary to Circular No. 17, and takes up the common spraying problems which must be understood and indicates the spraying practices which must be observed if the tree fruits are to be saved from the attacks of insects and diseases.

Demonstration Meetings.—In order to carry the practical information which is necessary to successful fruit growing, to the people who are most directly interested, a large number of dem-

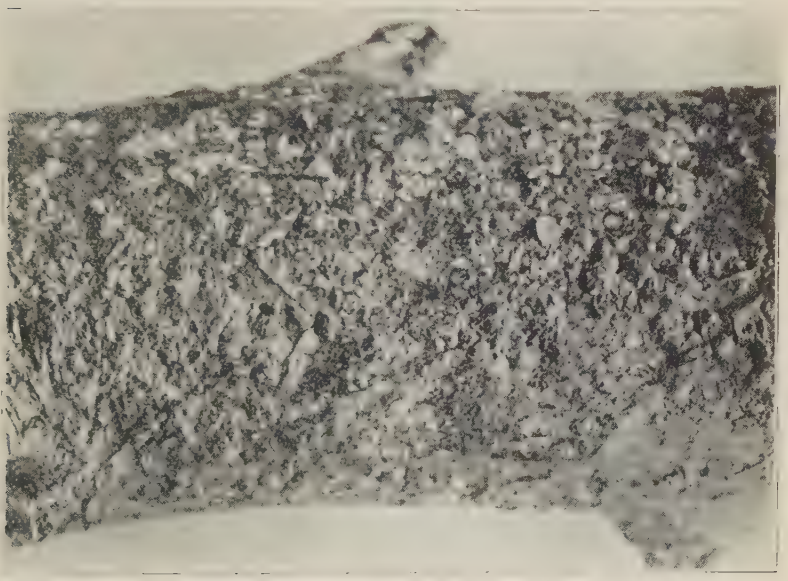


Fig. 29. San Jose scale only slightly enlarged covering the bark of an apple twig. The scale is seen by the naked eye simply as a grayish or nearly black scurfy coating and often appearing as if ashes had been sifted on the infested limb (From Bulletin No. 135)

onstration meetings has been held. These meetings take place in the open air in orchards selected for the purpose and talks are given on pruning, spraying and orchard management. Tools and spray pumps are at hand and the points brought out are illustrated by practical operations on the trees. Local conditions and practices are discussed and criticised and questions on orchard topics heard and discussed. The Department expects to continue this line of work during 1910 and full particulars will be forwarded on application, outlining the conditions under which a meeting may be secured by an interested community.

Tomatoes as a Farm Crop.—Investigations have been carried on for three years in regard to methods of growing tomatoes as a field crop for the canning factory. Indiana is in the front rank in the extent of the canning industry and about 30,000 acres are annually devoted to tomato growing. Bulletin No. 144 summarizes the studies that have been made along this line and gives directions for growing the plants, setting, cultivating, fertilizing, etc. Some of the problems brought out by the investigations are receiving further experimental study and will be reported upon later.



Fig. 30. Just after the petals fall and before the calyx lobes close up, is the stage of bloom at which the most important spraying for codling moth should be done (From Circular No. 17)

Cantaloup Improvement.—Spraying experiments on a commercial scale have been carried on with regard to the control of rust on cantaloups by spraying with Bordeaux mixture. It has been shown that this disease, which annually causes large loss to the cantaloup growers, can be held in check, and that spraying is profitable. Bulletins Nos. 123 and 135 bear upon the problems connected with melon growing and report the experiments which have been made

Studies of Catalpa and Locust Growing.—Extensive field studies have been made in many parts of the state to determine the best method of growing catalpa and locust for post and pole production and the profits which may reasonably be expected therefrom. This information will soon be available in printed form. In the meantime the Department will be glad to advise prospective planters through correspondence.

Improvement of Indiana Pecans.—Indiana possesses an undeveloped horticultural resource of great economic importance in the native pecans of the lower Wabash and Ohio river valleys. The



Fig. 31. At this stage, just before the flower buds open, spray with Bordeaux mixture to control the scab fungus

Department is endeavoring to locate and save the best native varieties and eventually hopes to propagate them to a sufficient degree to ensure their preservation. Many valuable sorts have been found already, which compare very favorably with the best named varieties of southern origin. Specimens of native nuts are solicited and advice will be gladly given in regard to the commercial possibilities of the business in Indiana.

STATE CHEMIST DEPARTMENT

W. J. Jones, Jr. E. G. Proulx C. W. Rice
F. D. Fuller C. Cutler S. P. Armsby

The official work of this Department consists in the administration of the laws regulating the sale of commercial fertilizers and concentrated commercial feeding stuffs in the state of Indiana and the settlement of disputes between coal oil dealers and inspectors. In view of the fact that the estimated value of the combined sales of fertilizers and feeding stuffs in Indiana during the past year reached a total of approximately $5,000,000, the importance of this work to the farmers of the state cannot be over-estimated.

FERTILIZER CONTROL LAW

The first fertilizer law in Indiana was passed in 1881 but as it provided only for the analysis of manufacturers' samples it was wisely amended by the legislatures of 1899 and 1901 to permit of the analysis of samples taken from consignments actually offered for sale in the state, thereby affording the protection to consumers which was desired.

Since the amended law became effective this Department has collected from all parts of the state 8403 samples with the result that while of 481 samples secured in 1899 and 1900, 322 or 67 per cent. were so much different from the guarantee as to seriously deceive the purchaser, of 969 samples analyzed in 1909 only 34 or 3.5 per cent. failed to be within 10 per cent. of the guaranteed value and only 138 or 14 per cent. showed a deficiency in any ingredient of 20 per cent.

When it is remembered that the amount of fertilizer sold in Indiana in 1909 was approximately 134,063.7 tons, an increase of 33⅓ per cent. in the past 10 years, representing an expenditure of approximately $3,000,000 on the part of the farmers of this state, the importance of the Fertilizer Control Law becomes apparent.

FEEDING STUFF CONTROL LAW

This law was passed by the legislature of 1907 in compliance with the demands of the farmers and feeders of the state for protection against the large amount of adulterated and inferior feeding stuffs then known to be sold in the open markets of Indiana. At that time most of the states, and especially those surrounding

Indiana had feeding stuff laws and it was evident that this state was serving as the dumping ground for low grade material that could not be sold elsewhere. Some law, therefore, regulating the sale of feeding stuffs in Indiana was absolutely necessary.

The Act as formulated was just and one that has met with the various requirements of such a measure as well as any that could be devised. It gives the farmers and feeders the protection they have a right to expect and has placed the traffic in feeding stuffs upon a strict business basis by making it possible for every one to know what he is buying and selling.

Briefly stated the objects of the law are as follows:

1. To have all feeds offered or exposed for sale or sold in the state labelled so that the consumer may have information as to their composition and the materials used in their manufacture.

2. To protect the consumer against adulterated or inferior feeds which up to the time of the passage of the law he had no means of recognizing.

3. To protect the honest manufacturer and dealer against dishonest competition.

4. To inform the consumer as to feeds which are the most economical to purchase and to promote the rational use of feeding stuffs.

The inspection of the past three years gives ample evidence that the law is accomplishing the purpose for which it was enacted. The microscopical and chemical analyses of nearly 4200 samples show that the use of the ordinary adulterants such as corn-cob meal, oat hulls, corn bran, screenings, sweepings, cotton-seed hulls, etc., have been practically eliminated and that the feeding stuffs offered for sale in this state are sold on their merits and for what they are, and not through misrepresentation regarding the raw material used in their manufacture.

It is gratifying to note that consumers are expressing a desire to investigate the feeding stuffs offered for sale and to purchase those needed to supplement the material grown on the farm. The sale of a large number of inferior feeding stuffs has been greatly reduced and in many instances such feeds have been entirely withdrawn from the Indiana markets, resulting in great benefit to the consumer and to the manufacturer of honest feeding material.

Since the enactment of the law to January 1, 1910, 15 violations have been adjusted. Many of these violations resulted from selling feed in packages which did not bear the State Chemist's tag showing the analysis and composition of the goods. In one instance in

particular, four and one-half tons of alleged cotton-seed meal were shipped without tags from Muncie to Farmland. On inspection this shipment was found to be cotton-seed feed meal containing approximately 55 per cent. cotton-seed hulls. The evidence in this case was presented to the grand jury and a true bill found. Settlement was made by the vender paying the purchaser $50.00 rebate due to difference in composition of material furnished and the cotton-seed meal contracted for. It is estimated that there were over 1700 tons of cotton-seed meal sold in Indiana in 1909.

Information received by this Department leads us to believe that prior to the passage of the Feeding Stuff Law a large percentage of the cotton-seed meal delivered in this state was mixed with cotton-seed hulls. If, and there is good evidence to indicate that such was the case, three-fourths of the cotton-seed meal sold was adulterated as in the case mentioned, the Feeding Stuff Law during the past year has protected the farmers of Indiana in the use of this one commodity alone to the extent of $14,163.75. Inasmuch as this Department receives a fee of 16 cents per ton to cover the expenses incurred in registering, inspecting and analyzing feeding stuffs and supplying stamps or labels for their sale, the saving of over $14,000 to the farmers of Indiana in the sale of cotton-seed meal alone during the past year would pay the cost of inspecting 88,524 tons of feeding stuff.

ADMINISTRATION

The laws are administered by the State Chemist and his deputies and the official business of the Department is limited to the inspection of fertilizer and feeding stuffs and the settlement of disputes between coal oil dealers and inspectors. The only funds available for carrying on the work of the Department are those received from the sale of tags and the revenue will not permit of the analysis of miscellaneous samples of water, soil, rocks, etc. Information regarding fertilizers, feeding stuffs and related subjects will be promptly furnished but the analysis of samples must be restricted to those taken by the State Chemist's deputies. These deputies are on the road throughout the year taking samples of fertilizers and feeding stuffs from goods on the market in all parts of the state.

Consumers of fertilizers and feeding stuffs are cautioned not to accept any package of either which does not have attached the State Chemist's tag bearing the minimum guarantee and other facts required by law and countersigned with his official signature.

In purchasing fertilizers, examine the State Chemist's fertilizer bulletin and purchase only of companies whose inspection results

show they are maintaining their guarantees and furnishing the amounts of fertilizing ingredients guaranteed.

In purchasing feeds, examine not only the guarantee of crude fat and crude protein but also the list of ingredients used in their manufacture.

If inspections are desired notify the State Chemist of the amount to be inspected and the official number of the fertilizer or feed and if the shipment justifies an inspection, an inspector will be sent to secure a sample without cost to the consumer.

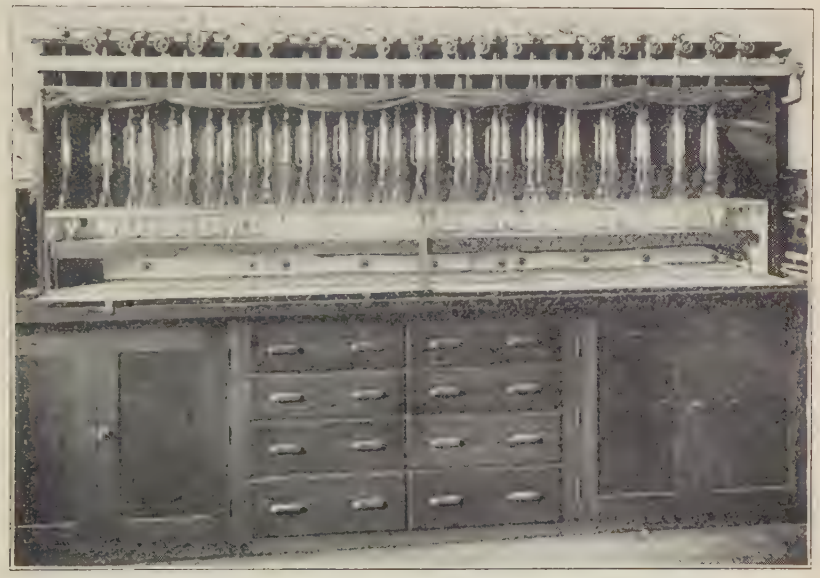


Fig. 22. Apparatus used in the State Chemist's laboratory for determining fat

The results of the inspection of fertilizers and feeding stuffs for the year 1909 will be found in Bulletins No. 148 and No. 141. Those interested in the purchase of fertilizers are advised to consult Bulletin No. 148 and those desiring information regarding the feeding stuffs sold in Indiana are referred to Bulletin No. 141. Copies of either of these bulletins can be secured free of charge by applying to the Director of the Experiment Station.

VETERINARY DEPARTMENT

R. A. Craig H. H. Madaus

HOG CHOLERA

Hog cholera exists in all sections of the United States, but it is especially prevalent in the middle west. In this section of the country it may be considered of greater economic importance than any of the other animal diseases. In our own state, the average yearly loss is about $3,000,000. It is difficult to make an exact estimate of the loss to the swine industry from this disease, as the statistics giving the death rate in swine include all diseases, but it is fair to assume that the greater portion is due to hog cholera. We should also include with the loss resulting from the high fatality, that resulting from the marketing of young hogs in neighborhoods where the disease is prevalent. This frequently amounts to 50 per cent. of the herd's value.

The Veterinary Department receives a large number of inquiries every year regarding the prevention and treatment of hog cholera. Bulletin No. 140 has been prepared for the purpose of informing farmers as to the investigation work of the past few years and methods of controlling the disease. Great interest has been shown in the Dorset-Niles hog cholera serum. The Department is producing and distributing this serum.

In ordering serum, the owner must state the condition, number and weight of the animals in the herd. Serum will not be furnished for the treatment of badly infected herds. For the present and until the method of vaccinating hogs is better understood by stockmen, serum will not be sent direct to them. So far as possible, a field man from the Department will visit and vaccinate or treat the herd. Serum may be secured through the local veterinarian and administered by him without extra charge to the owner.

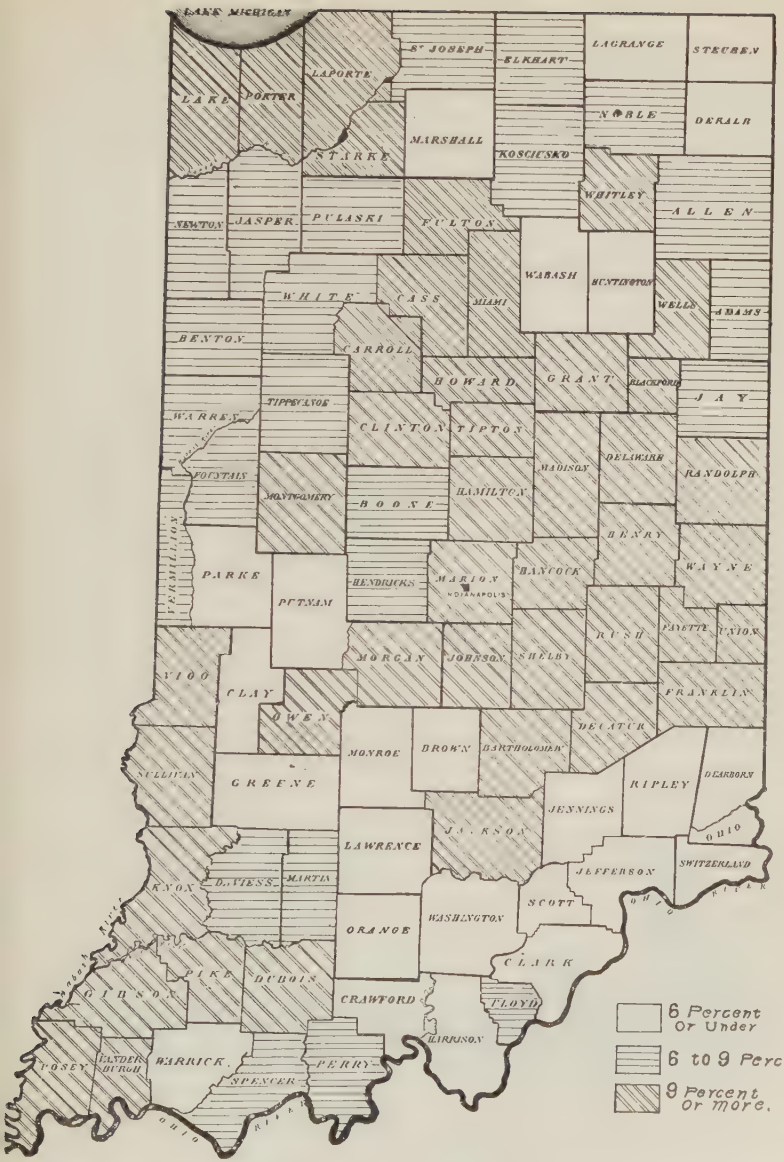


Fig. 33. Map showing per cent. of disease in hogs in different counties of state

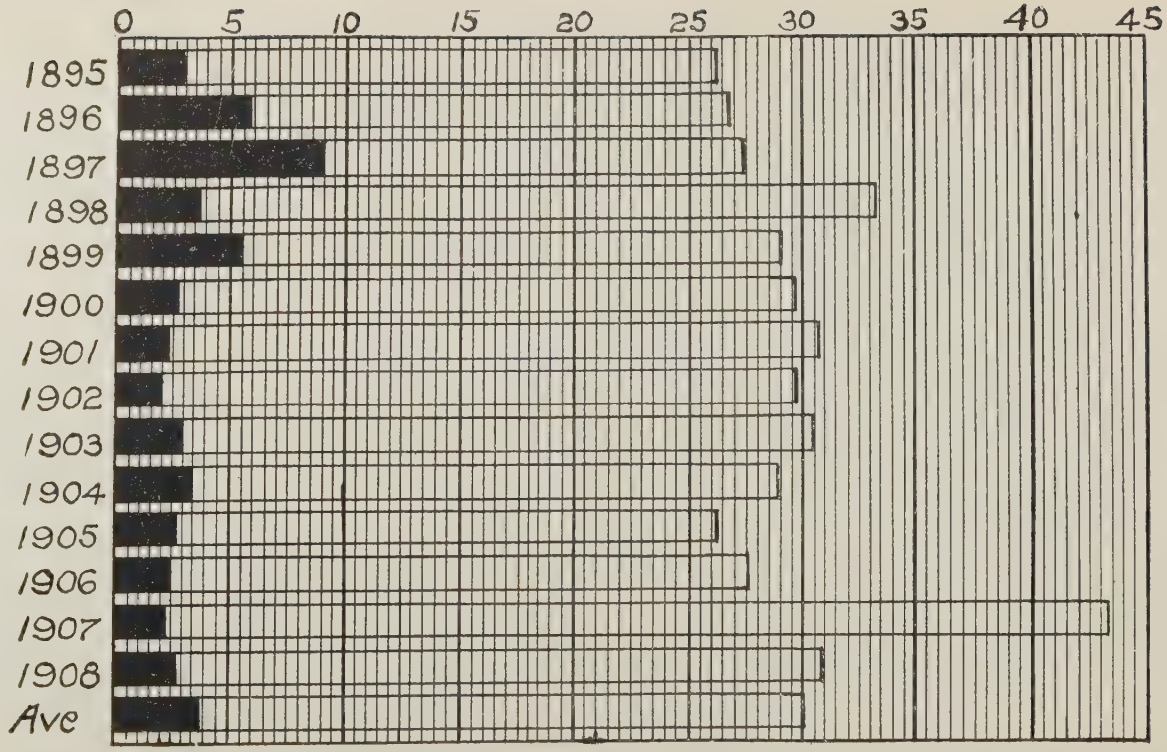


Fig. 34. Number of hogs raised and lost from disease in this state annually and the average for a period of 14 years. Blackened portions show number lost. Each heavy cross line represents 500,000 and light lines 50,000 each

SCHOOL OF AGRICULTURE

John H. Skinner, Dean

PURPOSE

The purpose of this school is to inspire a love for country life and give young men and women a broad, well rounded education; to educate them for the business of farming and other important positions requiring agricultural training. This is accomplished through a study of the many subjects covering the various phases of the great field of Agriculture, and the fundamental sciences, Biology, Chemistry, Physics, Mathematics, English and History. A large number of courses are prepared to meet the needs of farmers' sons and daughters. Those with limited means and preparation have been provided for as well as others.

INSTRUCTION

The instruction in Agriculture is practical and thorough, consisting of recitations, lectures and laboratory work in which agricultural science and practice are systematically taught. The student deals with the common every day problems of the farm, works with soil, plants, live stock, fertilizers, and dairy products, and is constantly working with the things with which he comes in contact on the farm. Agricultural students analyze soils, study crop rotations and production, judge grains, handle and judge live stock, study selection, feeding, breeding, production and care of live stock, practice grafting, budding, and pruning, judge fruits and vegetables, study the life history, characteristics and habits of insects and fungi and methods of preventing their ravages, make up mixtures for spraying, test grains and other seeds, adjust and operate farm machinery, separate and test milk, make butter and cheese, and study the production and care of dairy products, and thus secure practical knowledge of these various farm products and operations.

The School of Agriculture consists of five distinct departments, viz., Agricultural Extension, Agronomy, Animal Husbandry, Dairying, and Horticulture, to which a large corps of instructors devotes its time.

AGRICULTURAL EXTENSION

Professor Christie in Charge

The work of this Department comprises all those forms of agricultural instruction that aim to reach people on the farm and in the public schools. The Department attempts to place before these people the teachings of the School of Agriculture and Experiment Station. It also attempts to interest the young people of the farm and schools in agricultural studies and to impress upon them the importance and value of an agricultural education.

This work is accomplished through district short courses (which consist of practical instruction in agricultural subjects occupying a full week and given at a central place in the various congressional districts of the state), industrial clubs and contests, special educational trains, exhibits at county and state fairs, county farm tests, special literature, excursions from the various counties of the state to the University, and lectures before teachers' institutes, Chautauquas, farmers' institutes and other organizations.

AGRONOMY

Professor Wiancko in Charge

Professor Latta, Associate Professor Fisher, Assistant Professor Nye (Agricultural Engineering), Instructor Conner (Agricultural Chemistry), Assistants C. E. Craig, L. S. Mills

The courses of instruction in this Department are designed to give students a knowledge of the principles involved and the best practices followed in crop production and farm management, including detailed classroom and laboratory studies of all kinds of farm crops, their characteristics, culture and uses, the selection, preservation and testing of seeds, corn and other grain judging, systems of cropping and methods of crop improvement; the physical characteristics of various types of soils, systems and methods of tillage; the chemistry of soils and crops, the value and uses of manures and fertilizers, soil improvement and the maintenance of fertility; land drainage, the location and construction of drainage systems; the planning of farm buildings, the uses of cement on the farm, fencing materials and fence construction; the operation and care of all kinds of farm machinery; farm economics and the practical business of farm management and profitable production; the relation of theory, experimentation, science and practice in the advancement of agriculture.



Fig. 35. Studying weed seeds



Fig. 36. Studying the gasoline engine

ANIMAL HUSBANDRY

Professor Skinner in Charge
Professor Craig (Veterinary Science), Assistant Professor Smith, Instructors Arnett, Crane (Poultry)

The instruction in this Department is intended to give students a knowledge of the importance, and value of the live stock industry, the various classes and breeds of live stock, and to inspire a love for live stock farming. Instruction is given in the history and char-



Fig. 37. Students judging fat cattle

acteristics of breeds, the principles of breeding, animal nutrition and feeding, care and management, veterinary anatomy and physiology, veterinary medicine and surgery, and the production, fitting and marketing of horses, cattle, sheep, swine and poultry. Much time is given to practice in scoring, judging and selecting the various classes and types of animals for breeding and feeding purposes and to the tabulation and study of pedigrees, methods of registering, blood lines and family characteristics.



Fig. 38. Class judging Shropshire sheep



Fig. 39. Class judging draft horses at Lafayette Stock Farm

DAIRY HUSBANDRY

PROFESSOR HUNZIKER in Charge
INSTRUCTORS JARVIS, REED

The instruction in this Department deals with the dairy cow and her product. It is intended to train the student in the knowledge and practice of economic and sanitary milk production (how to select, breed and feed dairy stock for profit); the care and management of the dairy herd; judging dairy cattle; the secretion, composition, properties and ferments of milk; city milk supply; farm and



Fig. 40. Students testing milk



Fig. 41. Judging dairy cows at School of Agriculture

creamery buttermaking; creamery management, accounting and machinery; cheese making; the manufacture of condensed milk, ice cream, fermented milks, dried casein and miscellaneous products; testing milk and its products for purity and composition; state and federal dairy laws and milk and dairy inspection.

HORTICULTURE

Professor Troop in Charge
Instructor Boyle

The instruction in this Department is designed both from the standpoint of the commercial and the home grower of fruits and vegetables. It covers the field of pomology in which the principles involved in growing tree and small fruits are considered with respect to their propagation, selection, setting, pruning, training, thinning, spraying, classification, identification, harvesting, storing, and marketing; vegetable gardening as regards the selection of varieties, succession of crops, fertilizing, control of insects and fungus diseases, and the construction and management of cold-frames and hotbeds; landscape gardening as applied to the decoration of home grounds and small parks with regard to the selection, propagation, setting, and pruning of ornamental trees, shrubs and vines, establishing and renewing lawns, etc.; greenhouse management, taking up types of glass houses and forcing structures, methods of construction, heating and ventilation, and a study of the principal vegetable and floricultural crops.



Fig. 42. Students receiving instructions in pruning



Fig. 43. Laboratory practice in greenhouse work

UNIVERSITY CALENDAR

Fall entrance examination begins September 7, 1910

The Four Year Course will begin September 14, 1910

The Farmers' Short Course will be held January 9-14, 1911

The Winter School of Agriculture will open January 16, 1911

Full information concerning courses will be furnished on application to the Dean of the School of Agriculture

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 25

LaFayette, Ind., March, 1911

AGRICULTURAL EXTENSION

IX

HOW TO GROW MORE AND BETTER CORN

Indiana grows, annually, more than 4,600,000 acres of corn.

The average yield of corn in Indiana for the past 5 years has been 37.6 bushels per acre.

The cost of producing an acre of corn in Indiana is about $12.25.

A good seed ear in the spring ought to be worth 5 bushels of corn in the fall.

It pays to test your seed.

A 20-year comparison of cropping systems on the Station Farm shows that corn in various rotations containing clover, is now yielding an average of 24 bushels per acre more than corn grown continuously on the same land, and 20.6 bushels per acre more than corn grown in rotation with wheat only.

The last two crops in five different rotations on the Station Farm show an average gain of 17.1 bushels per acre from an average application of 4.5 tons of manure per acre.

Experiments in five representative counties have shown an average gain due to corn fertilization of 6.6 bushels per acre. The average cost of fertilizer was $1.11 per acre, leaving a net profit of $1.55 per acre, or $1.39 per dollar invested in fertilizer.

An increase of five bushels in the average yield per acre would mean an annual increase in the value of the corn crop of Indiana of $9,200,000.

The Experiment Station believes that a marked improvement in both yield and quality of corn is easily possible. Results of work done and methods of increasing the crop are discussed in the following pages.

Read this circular.

HOW TO GROW MORE AND BETTER CORN

INTRODUCTION

ARTHUR GOSS, Director

That corn is king in Indiana agriculture there can be no doubt. The value of the Indiana corn crop for the five years beginning with 1905, averaged $78,850,078 annually. This far exceeds the value of any of our other agricultural products. There is good reason why this should be the case, as more bushels of grain can be produced on an acre of land when planted to corn than when planted to any other grain crop. This being the case, however, it is also true that corn removes more plant food from the soil than any other grain crop; hence, in order to make successful corn production possible, it is necessary to keep the soil well supplied with available plant food.

Indiana farmers can point with much pride to the fact that of the leading corn producing states, including Ohio, Indiana, Illinois, Iowa, Nebraska, Kansas, Missouri, Kentucky and Texas, Indiana has headed the list in bushels produced per acre five times in the last 10 years. It is also a very significant fact that four of these times have fallen within the last six years, during which period an active campaign for corn improvement has been in progress in the state. In quality of product, Indiana also stands second to none. While this showing, together with the fact that Indiana has won the grand championship for the best 10 ears of corn at all four of the National corn shows, as well as first prize for the best bushel of corn every time that event has been included, and first prize for the best single ear three times out of four, is very gratifying to the ordinary Hoosier, it still leaves much to be desired. The fact that many of our best farmers are producing double the 37.6 bushels per acre the state has averaged during the past six years, shows that much can still be done by the application of proper methods, such as are outlined in this circular.

During the five-year period beginning with 1905, there were on the average 4,678,717 acres planted to corn in Indiana each year. An increase of but a single bushel per acre at 40 cents per bushel would mean an annual increase of $1,871,468 to the wealth of the state. Certainly this and much more can be accomplished. Let us all pull together and bring about an increase in production that will cause Indiana to continue in her present enviable position among the corn producing states of the Union.

SEED SELECTION AND CULTURAL METHODS

A. T. Wiancko, Chief in Soils and Crops

The character of the seed used is one of the most important factors in the production of a large corn crop, and especially because it is so liable to be defective. Fertile soil, good cultural methods, protection against insect enemies and plant diseases, are all of the utmost importance in contributing to the final results, but none of these factors can make amends for poor seed. A full stand of vigorous plants must be secured and the only way to secure it is by using good seed. Making sure of good seed is one of the cheapest and simplest ways of increasing the corn crop, but its very simplicity is a danger, since it causes so many farmers to overlook its importance.

In defining good seed we must think of several things. First, the variety of corn must be one that is adapted to the soil and climatic conditions where it is to be used. Second, the seed ears must come from well developed stalks growing under normal conditions. Third, the seed prepared for planting must be strong in vitality and the kernels graded to uniform sizes for the planter.

THE VARIETY OF CORN

In testing the relative productiveness of varieties of corn under the same conditions, enormous differences have been found. Such differences are inherent in the variety; they are varietal characteristics just as much as color, size of ear, or shape of kernel. There are many different varieties, or strains of corn, differing very much in yielding power. By selecting a high yielding variety, or strain of corn, that is adapted to his soil and climatic conditions, the farmer can add much to his crop yield without additional expense. It costs no more to tend a good variety than it does to tend a poor one. Good varieties can easily be secured. No one has a patent or monopoly on them.

In selecting a variety, care must be exercised to get one that will mature properly. Much loss has been occasioned by attempting to grow varieties that are too large and late for the locality. There is a wide range of difference between varieties produced in different latitudes as regards the length of season required for their proper development. The larger varieties of the southern portion of the state will not mature in the northern portion and the northern varieties will not occupy the full season, and are too small for southern Indiana. Seed corn should always be secured as near home as possible, or at least in the same latitude. Indiana has good varieties

for every section, or at least as good as can be found anywhere. Nothing better can be secured by going to other states.

There are, doubtless, many good varieties or strains of corn in Indiana with which we are not acquainted, but in the thousands of tests that have been conducted throughout the state in the last five years by this Station certain varieties have been found to be uniformly superior to others. Among these, the following may be named:

For the northern counties of the state: Early Yellow Dent, Wabash Yellow Dent, Dunn's Yellow Dent and Anson's White Dent.

For the north central counties: Reid's Yellow Dent, Hudson's Leaming, Pulaski County Golden Dent, Riley's Favorite and Silver Mine.

For the central portion of the state: Reid's Yellow Dent, Leaming and Boone County White.

For south central and southern Indiana: Johnson County White Dent, Vogler's White Dent, Pride of Indiana, Alexander's Gold Standard and Johnson County Yellow Dent.

These varieties are all more or less adapted to the sections under which they are named, the main differences arising in their relation to extreme soil types.

The farmer who has reason to be dissatisfied with the corn he is raising should look about for something better, and in this connection the Station may be able to give valuable assistance in suggesting a suitable variety.

After determining upon a suitable variety, the next step is to secure good, pure seed to start with by going to a good grower who has given some attention to corn improvement and who makes a practice of producing good seed. Here, again, the Station may assist by pointing out the best sources of supply.

HOME GROWN SEED

The ideal way to secure good seed corn is to produce it at home. No purchased corn can be as well adapted to the home conditions as that which may be developed on one's own farm, providing, of course, that one starts with a good variety. Corn is more sensitive to changed conditions than any other crop. The man who secures a good variety and then gives it careful attention, year after year, planting only the best ears out of the best part of his crop, has a much better chance of success than the man who depends upon purchased seed, unless, perhaps, in a case where a neighbor upon whom he can always depend, is giving special attention to the production of good seed.

By dividing the seed corn selected each year into two lots, putting the finest bushel or so of ears by themselves, and planting them in a small field by themselves, or on the side of a good field where there is protection from contamination from other varieties in neighbors' fields, and then selecting seed from this, one can surely and quickly further improve the variety for his particular conditions. Many of the best corn growers of the state are doing this and their methods are well worth copying. It may further be said that the highest yielding and finest strains of corn in the state have been developed in this way.

THE TIME TO SELECT SEED CORN

The best time to select seed corn is soon after the crop has matured, or at the latest, at husking time. Only well matured ears should be selected and the character of the stalk should be examined.

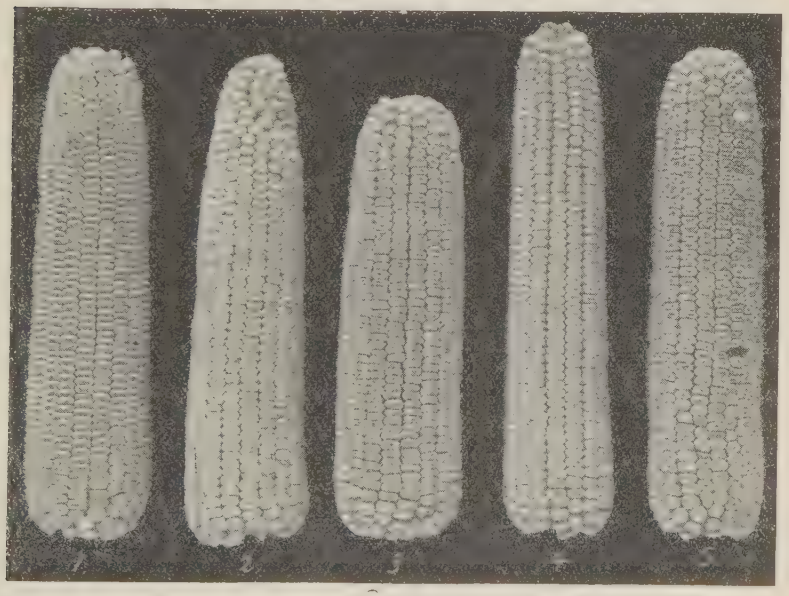


Fig. 1. Types of seed ears

Rather short, strong stalks growing under normal conditions of stand should be preferred. Almost any kind of a plant can produce a good ear if there are no others near it, but it takes a good plant to produce a good ear when there are no gaps in the stand, and the characteristics of such a plant will be inherited by the ear it pro-

duces. Only well matured ears that are held in good position on clean, thrifty looking stalks that stand up well and have a good leaf development should be selected. There is a limit to the size of ear that can be expected to ripen in an average season in a given locality. *Many farmers make the mistake of trying to raise corn that is really too large and too late for their conditions. By selecting only solid, well matured ears there is no danger of getting the variety too large or too late.*

The ears selected should be rather cylindrical in shape, strong and symmetrically developed, but not too thick. An ear having three inches of circumference for every four inches of length is about



Fig. 2. Various types of kernels

right. The rows of kernels should be straight and the kernels themselves uniform in size and shape. The indentation should be rather rough, but not so rough as to incline the kernels to chaffiness. The seed ears should always be a little rougher than the average of the crop, otherwise the variety will become smoother each year and the kernels shallower. The dent should run squarely across the kernel and should have no sharp or pointed margins. In Figure 1, ear No. 1 is of excellent type, ear No. 2 is too tapering, ear No. 3 is too thick, ear No. 4 is too thin, while ear No. 5 is weak near the butt.

The kernels should be deep and strongly developed. The tip of the kernel, especially, should be strong to give room for a large germ, which is essential to strong vitality and high feeding value.

The edges should be nearly straight, but they must converge towards the tips sufficiently to allow the rows to fit fairly closely together.

In Figure 2, pairs 5 and 9 are of excellent size and shape for a medium sized dent variety, measuring from a trifle under to a trifle over five-sixteenths of an inch in width, strong five-eighths of an inch in length and one-sixth of an inch in thickness. Pairs 1 and 2 are strong kernels, but they are lacking in depth. Pairs 3, 10 and 12 are too narrow and weak, showing chaffiness and lack of vitality. Pairs 4 and 7 are much too short and broad, and No. 8 is decidedly weak in the tips.

CARING FOR THE SEED EARS

All selected ears as they come from the field should be at once stored in a dry, well ventilated place and in such a way that there will be a free circulation of air around each ear. Much corn that is



Fig. 3. An inexpensive seed corn rack that will hold about six bushels of seed ears

intended for seed is injured by improper methods of storing and drying. It is most liable to injury during the first month or six weeks after husking. The outside of the ear may be dry and hard, but the cob and points of kernels may still contain much excess of

moisture, and it is this which so easily causes moulding, fermenting, or injury from freezing.

The best seed corn is that which matures and dries naturally. No farmer should attempt to raise a variety of corn that will not mature and dry out naturally. Corn that needs artificial help in drying is not suited to the local conditions. Fire drying should not be necessary, except under exceptionally unfavorable conditions, as in an unusually short season. Where fire drying must be resorted to, the heat should be applied slowly and good ventilation must be provided so as to let the moisture escape and thus prevent fermentation or moulding. After it is perfectly dry, seed corn will stand any amount of cold weather, but it must be protected from dampness.

There are a good many ways of storing seed corn, one of which is shown in the accompanying illustration (Figure 3). This rack is made from a bundle of laths and a few pieces of old fence boards and will hold about six bushels of seed ears.

FINAL SELECTION OF SEED EARS

The fall selection should include considerably more ears than will be needed for planting so as to leave room for culling. During the winter or early spring the ears should be carefully examined, culled, tested and reculled so that only the best may go to the planter. Before the outdoor work begins to press for time, this final selection and testing for vitality can be made comfortably and it should not be delayed beyond the middle of March. A good way to proceed is to lay the ears out in rows on a table in a well lighted place and go over them one at a time, throwing out all that are defective in any way. It is a good plan to hold a specially fine ear in one hand as a sort of pattern to select to.

THE GERMINATION TEST

No farmer can afford to neglect testing the vitality of his seed corn, no matter how carefully it has been stored. There are so many ways in which the vitality of seed corn may be injured that it is never safe to assume that all of it is in good condition. *There may not be a single ear that will not grow, but there are very likely to be odd ones that are weak, and these are the ones which the germination test will help to weed out.* Any one familiar with corn can detect a dead germ and pick out the ears that have been fatally injured, but a weak germ cannot be detected by any other means than the actual germination test. Every weak ear that goes to the planter means several hundreds of weak plants, or vacant places in the field, and a corresponding loss in yield.

The germination test may be made in various ways, but in all

cases each ear should be tested by itself. Experiments have amply shown that as a rule the testing of a few kernels, picked at random from different parts of the ear, will safely determine whether or not the ear should be used for seed. The individual ear test is the only means of finding out which are the poor and which are the really good ears.

The requisites for germination are moisture, warmth and air. Any convenient receptacle in which these can be provided will answer the purpose.

A GOOD TESTER

A convenient tester, and the kind we would strongly recommend every farmer to use, is shown in Figure 4. It consists of a



Fig. 4. A filled tester ready to be covered and set aside for germination

wooden tray about two inches deep, two and a half feet long and two feet wide, strung with light fence wire, one and three-quarter inches apart each way, and an inch and a half above the bottom, and filled up to the wires with moist sand. The cross wires permanently mark off the surface of the sand into one and three-quarter inch squares. Each square serves to hold the kernels to be tested from a single ear. If much corn is to be tested, several of these testers should be provided. They are easily made and with good care will last for many years. For the average farmer one will be sufficient, as about three bushels of seed corn can be tested at one time.

When making tests, some convenient system of arranging the ears on a rack, table or floor must be employed, so that the ear corresponding to a certain square in the tester may be readily located. The test should be made with about five kernels per ear, as shown in Figure 4, and they should be taken from various parts of the ear. One should look out for elevated or swollen spots when selecting kernels for the test, because wherever these occur the cob is probably more or less spongy, and retained moisture after the rest of the ear was dry and out of danger of being injured.

After the kernels have been placed, the material in the tester must be kept thoroughly moist. Sand is preferred because it is clean and easily kept in good condition. The kernels should be pressed well into the sand, but they need not be buried out of sight. The important thing is to keep them thoroughly moist. Some kind of cover for the tester must be provided, so as to keep the surface from drying. A couple of panes of window glass make the most satisfactory cover. With the glass cover, the soil needs to be moistened only once for each test. The cover should not fit too closely, as the germinating kernels must have some air. When moistening is necessary after the kernels have been placed, a towel or other cloth should be spread on the surface, and the water poured gently on top. If this is not done, the water poured on will move many of the kernels out of place.

The filled tester should be placed in a room where the temperature ranges around 70 degrees F., but not too near the stove. The ordinary living room is about right, provided that it does not become colder than 55 degrees during the night. *All kernels which do not send out vigorous root and stem sprouts within four or five days, under these conditions, should be considered as too weak to germinate properly under ordinary field conditions and the ears from which they came should be discarded.*

PREPARING THE SEED FOR PLANTING

After the seed ears have been properly selected and tested, they are ready to be shelled and the grain prepared for planting. The small and irregular kernels at the tips of the ears and the large irregular ones at the butts must be shelled off first and discarded. Irregular kernels in the body of the ear should also be discarded as completely as possible, so that only those kernels which are of uniform size and shape may go to the planter. This discarding of the small tip, large butt, and other irregular kernels is very important, because it is impossible for any planting machine to regularly drop the required number of grains per hill if they are not of the same size and shape. Many a poor stand of corn is due solely to ununiform seed.

Each ear should be shelled by itself and the grain spread out thinly and carefully examined for broken, mouldy, or otherwise damaged kernels. It is a good plan to use a set of screens of two sizes through which to pass the shelled corn, discarding that which is retained on the larger and that which passes through the smaller. When seed of ununiform size must be used, it should be graded into large, medium and small sizes, and a suitable planter plate used for each.

There are now on the market a number of simple machines for grading seed corn which are very useful when large quantities of seed are to be graded, but for the farmer who has only a few bushels of seed to prepare, the eyes and hands are the best graders.

TESTING THE PLANTER

Having graded the corn and made it as uniform as possible, we must next find the set of planter plates that will drop the required number of kernels at least 95 times in every hundred. The planter should be set up in a convenient place and operated by hand, running through a sample of the corn to be planted and using plates with different sized openings until a pair is found that will drop the desired number of kernels every time, if possible. If the best plates available are not quite satisfactory, the notches must be filed until they do the work as required. All up-to-date planters are supplied with a number of plates of different sizes, so that it is only necessary to select the right set for the corn to be planted.

To some of our readers it may appear that what we are herein recommending is a little too much trouble, but they may rest assured that the matter has been carefully investigated and tested and that it will pay well to give such careful attention to the selection and preparation of corn for planting.

THE PLACE OF CORN IN THE ROTATION

To get the most profitable returns, corn must never be grown on the same land continuously. The only exceptions to this rule are the bottom lands which regularly overflow, and perhaps some peat and muck soils upon which field crops cannot be regularly rotated. On all other lands, continuous corn cropping soon results in a marked decrease in production. All experiments in continuous corn cropping on lands other than the exceptions mentioned above have shown that the practice is ruinous, no matter what the system of manuring or fertilizing may be. Corn has shown itself more sensitive to the ill effects of growing continuously on the same land than any other of our common field crops.

In the crop rotation experiments carried on by this Station at LaFayette since 1889, a number of rotations, including corn, have been studied. A comparison of the results up to the present time shows very clearly that continuous corn cropping, and the culture

of corn in exclusive grain crop rotations, are not profitable. There has been a very marked falling off in the yields of corn on the continuous corn cropping series, both on the fertilized and unfertilized plats. The average falling off in the fertility of the ground in the corn and wheat rotation has also been large, while in the longer rotations there have been some substantial gains. The results of these experiments leave no doubt of the profitableness of clover, or clover and grass in the rotation, especially when the cost of fertilization is considered.

The following table shows the average corn yields in 1889, the year the experiments were begun, in the upper portion; the yields produced in 1909 in the middle portion, and the differences in the lower portion of the table, in five different rotations at this Station, with and without fertilization.

TABLE I—Comparative Corn Yields at Beginning and End of 20-Year Period in Different Rotations at Purdue Experiment Station

Treatment	Cropping systems and yields in bushels per acre				
	Series I Continuous corn	Series II Corn and wheat	Series III Corn, oats, wheat and clover	Series IV Corn, oats, wheat, clover and grass	[1]Series V Corn, roots, oats, wheat, clover and grass
	Yields in 1889, when the experiments were begun				
[2]Unfertilized	61.1	50.0	54.6	54.2	58.4
[3]Fertilized	62.1	49.3	54.8	56.4	58.1
	Yields in 1909, after 20 years of cropping				
[2]Unfertilized	26.0	25.4	47.8	35.5	61.1
[3]Fertilized	39.9	47.3	59.1	65.5	73.1
	Differences between 1889 and 1909 yields, showing effects of rotations				
[2]Unfertilized	—35.1	—24.6	— 6.8	—18.7	+ 2.7
[3]Fertilized	—22.2	— 2.0	+ 4.3	+ 9.1	+15.0

[1]In series V, the rotation was changed in 1907 to corn, wheat, clover

[2]Average of three plats in each series, except in Series IV, which has four unfertilized plats

[3]Average of four plats in each series, except in Series IV, in which there are only three

In this comparison, every factor except crop rotation is eliminated on the unfertilized plats, and the differences shown are attributable to the effects of the cropping system only. The season of 1909 was a favorable one for corn and the yields produced are a fair measure of the present productiveness of the soil in the various series. The enormous drop of 35.1 bus. per acre in the corn yields of the unfertilized plats and 22.2 bus. on the fertilized plats of the continuous corn series as compared with a drop of only 6.8 bus. on the unfertilized plats and a gain of 4.3 bus. on the fertilized plats on the corn, oats, wheat, clover rotation and a gain of 2.7 bus. on the unfertilized plats and 15.0 bus. on the fertilized plats of the corn, roots, oats, wheat, clover and grass rotation clearly shows the benefits of rotation as affecting corn yields. It will be noticed that the corn and wheat rotation plats have also fallen off considerably in fertility. On the fertilized plats in the corn, oats, wheat, clover and grass rotation, there has been a gain of 9.1 bus. as compared with a drop of 22.2 bus. per acre on the corresponding plats in the continuous corn series. The drop of 18.7 bus. per acre on the unfertilized plats in Series IV may be at least partly explained by injury from the root louse, which was especially troublesome on the unfertilized plats in this series in 1909. Summing up the results in another way, we see that the difference between the average of the two series cropped with corn and corn and wheat and the average of the three series containing clover and clover and grass in the rotation is 21.9 bus. per acre on the unfertilized plats and 21.6 bus. per acre on the fertilized plats in favor of the latter. At 40 cents per bushel, the average of these differences in favor of the three better rotations amounts to $8.70 per acre for the grain alone. On the average corn acreage of the state of Indiana the above difference in favor of crop rotation would amount to over $40,000,000 per year.

At the Ohio[1] and Illinois[2] stations, large differences in favor of rotation have also been observed.

Corn is by far the most important crop grown in this state and on practically every farm it is likely to retain its present prominent position. What other crops should be rotated with it is a problem which every farmer must largely work out for himself according to his particular conditions, remembering that to get the best results a rational rotation must be practiced; that is, the corn crop must be alternated with some other suitable crops. What these other crops should be and how many different ones should be included in the rotation will depend upon a number of factors, among which are the

[1]Ohio Experiment Station Bulletin No. 184
[2]Illinois Experiment Station Bulletin No. 125

kind of farming carried on, the kind of soil and its degree of fertility, the kinds of crops which the local conditions will best produce and the extent to which they may be profitably used in the system of farming followed. One cardinal principle, however, must never be forgotten, and that is that some kind of a legume, usually clover, should have a prominent place in the rotation.

Broadly speaking, the three-course rotation of corn, wheat or oats, and clover will usually be found most suitable on the better class of soils, using cow peas in the place of clover when the latter fails, putting manure on the corn and commercial fertilizer on the wheat. In order to provide the necessary manure and profitably use the legume, every corn grower should be a feeder of livestock. On the less fertile soils, or those otherwise not so well adapted to corn, a longer rotation may be advisable, as for instance, corn, small grain, clover and grass, using legume cover crops and liberal applications of manure and fertilizer. Another rotation, and one which is well adapted to keeping up or improving the fertility of the soil and seems well worth trying wherever soy beans or cow peas will do well, is a four-course one consisting of corn, soy beans or cow peas, small grain and clover. In this case both corn and small grain may follow legumes which are admirably adapted to precede them. There is abundant evidence which goes to show that whatever rotation is adopted, the corn should always follow a legume, as there is nothing else that will so well or so cheaply fit the soil to produce corn.

SOIL PREPARATION

The first requisite for profitable corn culture so far as the soil is concerned, is good drainage. It is folly to attempt to produce a good corn crop on wet ground, no matter how careful the tillage operations may be. If the ground is not naturally well drained, it must be carefully tiled. A good system of underdrains on naturally wet or close textured soil will soon pay for itself and should in no case be neglected.

The ground for corn must be made loose and mellow by deep plowing and careful harrowing. Corn requires a deep, mellow and warm seed-bed. The plowing must be done in such a way that the furrow slice will be thoroughly broken up and mellowed from top to bottom. Ground for corn should never be plowed when wet. This is especially important in the case of heavy soils, as no amount of later working will bring the soil back into proper tilth. Too many farmers make this mistake.

The best time to plow ground for corn will depend upon the local conditions as to the character of the soil, lay of the land, climate and previous crop. In localities where there is much winter

rain, or the land is hilly or inclined to puddle, fall plowing is not advisable, although an exception may be made of tough sod. On reasonably level lands that will not wash, the question of whether to plow in fall or spring is largely one of convenience, as no definite effect upon corn yields has been observed. Grass lands, however, may be profitably plowed in the fall as this helps to kill injurious insects, unless it is desired to apply manure during the winter. In the northern counties of the state where there is much freezing and little winter rain, fall plowing will be more beneficial, and especially if it will hasten drying and getting the soil into condition for planting in the spring. In fall plowing, the furrows should be well set up and the land left as rough as possible for the frost to act upon it.

Where corn follows clover, as should usually be the case, and especially where manure is to be applied during the winter, the plowing should be done in the spring and then as soon as the soil is dry enough. The furrow slice should never be thrown down flat and a jointer should always be used, especially for sod. If manure is to be turned under, a drag chain should be used to get it well covered. On stubble land, and even clover sod, whether manured or not, disking ahead of the plow in spring should be practiced to more thoroughly pulverize the furrow slice and mix some soil with the manure or other organic matter before it is covered, thus preventing any tendency to cut off the capillary rise of moisture. *Spring plowed ground should always be dragged or harrowed at once to prevent the formation of clods and loss of moisture.* It is a true saying that the farmer can do more to insure a good corn crop by thorough soil preparation before planting than by any amount of later cultivation.

TIME OF PLANTING

The best time to plant corn will depend upon the weather conditions and the condition of the seed-bed. The soil must be mellow and warm. Corn is a warm weather plant and must never be planted in cold or wet soil. In southern Indiana, on well drained soil, the planting can usually be done in the last few days of April or the first few days of May, while in northern Indiana where spring comes later, it will usually be the middle of May before conditions are favorable. The only rule that can be followed is to plant as soon as the weather becomes warm and the seed-bed can be put into good condition. Corn needs a long season of growth in order to do its best and planting should always be done as early as the soil and weather are fit. Good drainage and proper tillage methods will do much to make early planting possible.

METHOD OF PLANTING

Whether corn should be drilled or check-rowed will depend largely upon the likelihood of trouble with weeds. On clean ground, it matters little which method is used and, perhaps, drilling may even give better results on account of the more equal distribution of plants. As there are few cases, however, where there is not some danger of trouble with weeds, it is usually considered safest and best to plant corn in hills which can be cultivated both ways. By careful checking, so that the rows will be as straight crosswise as lengthwise, the most thorough cultivation can be given and weeds can be most completely destroyed.

In this portion of the country, it is best to surface plant corn, although a furrow opener may be used to good advantage on uneven or cloddy ground when it is set merely deep enough to push aside the clods and thus insure a more uniform depth of planting and covering.

The depth of planting should be as shallow as possible, especially early in the season, merely getting the corn down to moist soil and insuring proper covering. Later in the season when the ground is warmer and likely to be drier, deeper planting may be advisable. On the heavier soils, planting should generally be shallower and must be more carefully done than on the lighter, looser soils.

THICKNESS OF PLANTING

In determining the best thickness of planting to produce the largest yield of good corn per acre, the fertility of the soil and the size of the variety are the most important factors to be considered. About the only rule that can be laid down is that the richer the soil and the smaller the variety, the thicker should be the planting and the poorer the soil and the larger the variety, the thinner should be the planting. In the northern part of the state, where the varieties are smaller, closer planting may generally be practiced than in the southern portion, where the varieties commonly grown are larger. In check-rowing, 3 feet 6 inches apart each way should be the maximum distance of planting and with this distance between hills, three kernels per hill will usually give better results than two kernels per hill. In a recent publication giving the results of thickness of planting experiments in Illinois,[1] it is shown that better results may be secured from planting closer than is commonly practiced.

[1]Illinois Experiment Station Bulletin No. 126

CULTIVATION OF CORN

In cultivating corn, the prime objects to be attained are to keep the soil mellow and free of weeds. Unless the ground is too wet, the first operation after planting should be to give the field a general harrowing. If the ground has become at all crusted, this should be done before the corn comes up. Otherwise, it may be done after the corn is well up, and preferably during the heat of the day, when the leaves are not so brittle. This general harrowing will do much to destroy the small weeds that have started. The first regular cultivation should then be given as soon as the rows can be easily followed. The intervals between subsequent cultivations must be timed according to the condition of the soil and the danger of trouble with weeds. Whenever a crust forms on the soil, it should be cultivated no matter how soon that may be after the last previous cultivation. In cultivating corn, the ground should always be kept as level as possible.

No definite rule can be laid down as to frequency of cultivation. The condition of the soil, the character of the season, and the trouble with weeds must be considered as guides. The cardinal principles of keeping down weeds and preserving a loose soil mulch must ever be kept in mind. Cultivation may profitably continue until tassels begin to show. When the corn becomes too large for two-horse cultivation, a one-horse, harrow-tooth cultivator should be used. Dragging a mower wheel between the rows in place of the last cultivation with the harrow-tooth cultivator is recommended by some and answers the same purpose. Under ordinary conditions about six cultivations will be found profitable. In a recent experiment, continued for four years by this Station, six cultivations, four ordinary and two one-horse, gave the best results.

As to the depth of cultivation, it seems advisable under ordinary conditions to cultivate deep the first time and then go a little shallower each time until the third cultivation is reached, after which it should be as shallow as possible, in order to prevent injury to the roots. When the soil is in good condition and there is no trouble with weeds, the cultivation may be shallow throughout the season. If the soil is well prepared before planting, it seems that the main benefit of cultivation is to be derived from keeping down weeds and preventing baking of the soil.

Ordinarily, the kind or type of cultivator that should be used does not seem to be important. More depends upon the skill with which the implement is used than upon its kind. In the four years of experimental work referred to above, which included a test of

the various kinds of cultivators, no definite conclusions could be drawn as to the choice of cultivator, except, perhaps, that the exclusive use of the one-horse cultivators does not seem advisable. If the weeds become large, the disk and the larger shovel cultivators are most serviceable in destroying them. For ordinary work, beginning the two-horse cultivator with one of the medium sized shovel cultivators or a disk and ending with a small shovel seems to be most advisable. If only one cultivator is to be used, it should probably be a four-shovel gang or a disk.

HARVESTING THE CORN CROP

Without discussing the large subject of how to utilize the corn crop, probably the only thing that need be said here is that farmers should make better use of the stalks. An enormous amount of good forage is annually wasted in Indiana by leaving the corn stalks standing in the field. The use of the silo for a part of the crop is to be recommended. The rest should be cut and shocked as soon as it is ripe. It may then be either put through the shredder or husked from the shock and the stover fed as it is, or first shredded. All must admit that the stalks contain a large amount of valuable feed which should not be wasted.

MAINTENANCE OF SOIL FERTILITY

J. B. Abbott, Associate in Soils

SOIL FERTILITY DEPLETED BY PRESENT SYSTEM OF FARMING

The time is at hand when the matter of providing food for the corn crop must be given more attention. When this country was new the soil contained stores of plant food and decaying organic matter which had been accumulating for centuries, and the yield of corn seemed to be limited only by the cultivation given it and the quality of the seed; but the country is no longer new, and the condition of the soil has changed. The accumulated stores of available plant food have been turned into crops and removed from the land; the decaying organic matter has been largely used up, and the yield is now quite generally limited by a shortage of available plant food, and by bad physical condition of the soil. In many cases lime has become deficient, and soil acidity has become a serious limiting factor in the yield of corn, not so much directly as indirectly through its unfavorable effect upon the clover crop and upon the processes of decay and nitrification in the soil. The practical problem now before us is the development of a system of agriculture that will give profitable crops year after year and at the same time permanently maintain the fertility of our best soils and improve the fertility of the others.

PLANT FOOD

The food used by the corn crop consists of compounds of ten chemical elements, and a sufficient supply of each one in a readily available form must be present at all times or the crop cannot grow. One of these elements cannot take the place of another any more than rainfall can take the place of cultivation. All are necessary and if the supply of any one, phosphorus for instance, is only great enough to produce thirty bushels of corn per acre, there will be only thirty bushels, no matter how abundant the others, no matter how perfect the cultivation, and no matter how good the seed. Three of these essential food elements, nitrogen, phosphorus and potassium, exist in the soil in available forms in rather small amounts and are used by crops in rather large amounts; hence, after a few years cropping accompanied by the removal of the crop, or part of the crop, from the land the available portion of these elements becomes exhausted and satisfactory yields can no longer be secured.

If the land could be allowed to rest for a few years, nature would partly repair the damage, but that scheme is not practicable. The practical thing to do is to add the deficient element or elements in sufficient amounts as cheaply as possible and go on raising crops. This is exactly what we are trying to do when we use manure, clover, fertilizer or lime.

When we use manure, we are adding to the soil nitrogen, phosphorus, potassium and decaying organic matter. When we plow under clover, we are adding nitrogen and decaying organic matter, but no phosphorus or potassium. When we use commercial fertilizer, we are adding one or more of the chemical elements, but no appreciable amount of decaying organic matter. When we use lime, we neutralize and render harmless certain poisonous acids in the soil, stimulate the development of beneficial bacteria and render available more or less potassium from certain minerals in the soil. It is possible that in rare cases lime may also be deficient as a plant food.

AMOUNT OF PLANT FOOD IN THE SOIL

The amounts of nitrogen, phosphoric acid and potash contained in the plowed surface of one acre of representative Indiana soils to a depth of seven inches, is shown in Table II following. These figures are not presented to give the idea that the fertility of a soil or its fertilizer requirements can be determined by chemical analysis, for such is not the case, but rather to emphasize the great differences naturally existing between different kinds of soil, and to show that the supply of plant food in the soil is by no means unlimited. It naturally follows that the different kinds of soil demand quite different treatment, and that no kind of soil will long remain fertile under a system of farming involving rapid removal of plant food from the soil with no return.

Only a small part of the plant food in the soil is available to crops at any one time, so it is necessary to have in the soil at all times a large enough amount of plant food so that the small portion which becomes available from year to year will amount to enough for maximum crop production. In other words, the necessity for a greater supply of available plant food arises much sooner than would be at first thought from a study of Table II, and from the practical standpoint, soils become badly exhausted long before the plant food is all removed. For example, clay soils in general do not contain enough phosphoric acid so that the portion becoming available each year amounts to enough for maximum crop production. There are two common methods of overcoming this de-

ficiency. The commoner one is to add from year to year only as much phosphoric acid as the crop needs, all of it in an available form, such as acid phosphate or steamed bone meal. The other method is to add to the soil a large enough amount of a cheap, slowly available phosphate, such as raw rock phosphate, to increase the total phosphoric acid content of the soil up to a point, where the portion becoming available from year to year will amount to enough for maximum crop production without the use of the more expensive soluble phosphates. Each method is good and has its advocates, but in our opinion the question as to which one is best is still open. Our experiments are not yet conclusive. Raw rock phosphate produces very little effect until the second or third year after application and, hence, is not to be considered where immediate results are desired.

TABLE II—Pounds of Plant Food Contained in One Acre of Representative Indiana Soils to a Depth of Seven Inches

	Peat	Black sandy loam	Brown loam	Clay loam	White clay	Sand
Nitrogen	33,200	7,000	5,400	3,000	2,200	600
Phosphoric acid	3,500	2,800	3,000	2,400	1,600	500
Potash	3,900	31,600	46,200	40,400	36,000	25,400

TABLE III—Pounds of Plant Food Contained in Corn, Clover and Manure

	Corn			Red clover	Manure[1]
	Ears, 100 bus.	Stover, 3 tons	Total	2 tons	10 tons
Nitrogen	102	48	150	84	100
Phosphoric acid	40	14	54	17	50
Potash	25	86	111	83	100

[1]The composition of manure is extremely variable but the estimates given are thought to represent the approximate composition of average manure

AMOUNT OF PLANT FOOD CONSUMED BY A CORN CROP

The amounts of nitrogen, phosphoric acid and potash which are contained in 100 bushels of corn, both grain and stover, are shown in Table III above. Besides this draft on the soil, a large amount of the organic matter in the soil is caused to decay or burn out by the

frequent cultivation given the corn crop, and lime is always being leached out of the soil and removed in crops, but exact data as to the magnitude of these losses are not available. As a matter of fact, soils vary so much that an exact determination of the losses from one field would be of little practical value in estimating the losses from another field, and in practice, the only way to handle the problem is to replenish the supply of lime and decaying organic matter whenever necessary, as determined by experience, observation and field trial. We know, in a general way, that the lighter and more open the soil, the faster these materials are used up and the oftener they must be replenished.

THE RELATION OF LIVE STOCK TO SOIL FERTILITY

Any system of cropping is necessarily more or less exhaustive of soil fertility, in that it involves the removal of certain products from the fields with consequent loss from the soil of the plant food contained in those products, but a system of live stock husbandry is much less exhaustive than a system of grain farming.

Under a system of straight grain farming, unless considerable amounts of plant food are brought in from the outside, it becomes impossible to maintain an adequate supply in the soil to indefinitely maintain profitable crop production. Under such a system, the most satisfactory method of maintaining the supply of nitrogen and organic matter in the soil is by growing and plowing under clover, cow peas, or other legume crops, in addition to the stalks and straw. Under a system of livestock farming on the other hand, the legume crops, as well as the stalks and straw, can either be fed or used as bedding before being applied to the land in the form of manure, thus insuring a double profit from the use of the same.

It is probably fair to assume that as an average, 80 per cent. of the plant food contained in a ration passes on into the manure, and if the manure is economically handled, a large portion of this plant food can be gotten back into the soil, though as a matter of fact, it is pretty difficult to avoid considerable loss, no matter how well the manure is handled. A little carelessness may easily result in the loss of more than half its value, since two-thirds of the nitrogen and four-fifths of the potash in a ration are voided in the urine, and unless the liquid manure is saved by absorbent bedding and a tight floor, the loss of these two elements is particularly heavy. The possible losses through heating and leaching are equally serious and must be guarded against with the utmost care.

We are often asked what manure is worth but it is perfectly evident from the foregoing statements that no definite value can

be assigned. It is variable and depends upon the ration from which the manure is made, the age and kind of animals, and the care given it, and in general is closely proportional to the care. Manure allowed to stand in piles and heat, or allowed to stand under the eaves and leach, and hauled whenever convenient, probably does not cost as much as manure made under a covered shed or on a concrete floor, but it certainly is not worth as much, ton for ton. One ton of manure of average composition contains plant food which would cost about $2.00 to replace in the form of the cheapest fertilizing materials, and that valuation is perhaps as fair as any. The agricultural value or crop producing power of manure will vary with the kind of manure, the care given it, the soil upon which it is used, the crop grown, the season, and perhaps a few other factors, but some sort of an idea as to the crop producing power of manure made under ordinary farm conditions may be gotten from the results of experiments summarized in Table IV following:

TABLE IV—Value of Manure Under Different Cropping Systems[1]

Amount of manure applied per acre	Bus. per acre yield	Bus. per acre increase	Bus. increase per ton of manure applied to corn	Value of increase of corn only per ton of manure applied to corn	Value of increase of all crops per ton of manure applied in one rotation
Continuous Corn. 16-Year Average					
None	18.15				
2½ tons	28.92	10.77	4.3	$1.72	$1.72
5 tons	38.45	20.30	4.06	$1.62	$1.62
Corn, Oats, Wheat, Clover, Timothy Rotation. 16-Year Average					
None	30.49				
4 tons on corn, 4 tons on wheat	44.03	13.54	3.38	$1.35	$2.88
8 tons on corn, 8 tons on wheat	51.11	20.62	2.57	$1.03	$2.30
Corn, Wheat, Clover Rotation. 13-Year Average					
None	33.87				
8 tons, from open yard	51.17	17.30	2.16	$0.86	$2.26
8 tons, from stall	58.16	24.29	3.03	$1.21	$3.19

[1]From Ohio Agricultural Experiment Station Circular No. 104

Manure does not contain enough phosphoric acid to be a well balanced corn fertilizer, and since crops use only enough of the abundant foods to balance the available supply of the most deficient food, it is probable that some of the nitrogen in manure goes to waste because of lack of available phosphoric acid to balance it. For this reason the practice of reinforcing manure as it is made, with acid or rock phosphate at the rate of 40 pounds per ton is recommended. At the Ohio Experiment Station, yard manure when used at the rate of eight tons per acre on corn only, in a corn-wheat-clover rotation, increased the net value of crops produced $2.26 per ton of manure, and under the same conditions, manure reinforced with acid phosphate at the rate of 40 pounds per ton increased the net value of crops produced $3.72 per ton of manure, a net gain of $1.46 per ton of manure. Reinforcement of manure with phosphates is a profitable practice and cannot be too strongly urged.

NITROGEN FROM LEGUMINOUS CROPS

Ordinary plants are absolutely dependent upon the supply of combined nitrogen in the soil, and can derive no benefit from free atmospheric nitrogen until it is brought into chemical combination by bacteria or other agencies, but legumes, when inoculated with their particular species of tubercle forming, nitrogen fixing bacteria are able to fix and use atmospheric nitrogen. Legumes, however, can and do feed upon soil nitrogen, and in general, seem to use atmospheric nitrogen in large amounts only when they fail to get a sufficient supply from the soil. Thus, clover growing on heavily manured land may get a large part of its nitrogen from the manure and in such a case may not be of very great use in increasing the supply of that element in the soil.

The nitrogen fixed and used by the clover crop does not all remain in the tubercles or roots. Most of it is rapidly transferred to the top part of the plant, as is evidenced by the superior growth of well inoculated plants, and in case the crop is removed from the soil, the nitrogen in it goes too and leaves the soil little or no better off than before so far as nitrogen is concerned, and poorer by at least eight pounds of phosphoric acid and 40 pounds of potash per ton of hay removed. It will be seen from this that the practice of cutting the clover hay crop and selling the hay or wasting the manure produced from it, and then, perhaps, harvesting the seed crop and wasting the chaff, cannot be too strongly condemned. Such a system does not benefit the soil at all but on the contrary, is as ruinous as continuous grain cropping.

Pasturing clover results in only a small loss of plant food which is more than counterbalanced by the profit made on beef, pork or dairy products. Using it for hay results in a considerably heavier loss, but even this need not be so excessive as to condemn the practice, providing the manure is well handled, but selling the hay, wasting the manure, or any other practice involving heavy losses of plant food without adequate returns, is not to be tolerated. It means an immediate financial loss and final soil exhaustion. The effect of clover in maintaining the fertility of the soil on the Experiment Station Farm is shown in Table I on page 12 and is discussed in connection with the question of rotations. It should be noted in this connection that the hay crop has been removed and only the seed crop left on the soil, so that the beneficial effect is probably not nearly so great as it would have been had the crop been more economically handled. The plats to which some manure was returned probably give a fairer showing of the true value of clover.

THE USE OF COMMERCIAL FERTILIZER ON CORN

For the past five years this department has been conducting corn fertilization experiments in cooperation with farmers in various parts of the state, with a view to determining what element or elements are seriously deficient in the soil and what is the most profitable fertilizer formula to use for corn fertilization. So far as can be deduced from our results there is but little difference in the requirements of the various clay and loam soils as far as commercial fertilizer is concerned; that is, there is not any clearly defined difference that would indicate the use of materially different fertilizers, though of course, some soils respond to fertilization much more satisfactorily than others. In general, it is to be noted that the use of commercial fertilizer on corn has not given as profitable returns as on wheat, and that ample supplies of slowly available nitrogen and readily fermentable organic matter, such as are furnished by manure and clover, seem to be relatively more important. It is no uncommon thing to raise 30 bushels of wheat per acre on poor clay soil simply by using 200 to 300 pounds per acre of commercial fertilizer, but the use of the same amount of fertilizer alone will practically never result in a proportionately large corn crop on the same kind of soil and this is to be expected, as a crop of corn requires two or three times as much food as a corresponding crop of wheat. Fertilizer used as a supplement to a clover sod, however, frequently does give very large returns, and while this may be due partly to the improved physical condition of the soil brought about by the clover, it is probably more largely due

to the large amount of nitrogen and easily fermentable organic matter furnished by the clover. Corn must have nitrogen and a lot of it, but it would be folly to think of buying it in the form of commercial fertilizer. The nitrogen present in a 75 bushel corn crop would cost between $25 and $30 at current fertilizer prices and as the crop cannot utilize all that is applied in the form of fertilizer, the cost of nitrogen to produce 75 bushels of corn would be considerably greater than those figures.

In our simplest corn fertilization experiments we use seven plats, each four rows wide. The one in the middle and the ones at each side are left untreated as a check upon the uniformity of the piece of land selected. The other plats are fertilized, generally at the rate of 200 pounds per acre drilled in the row. A complete fertilizer containing nitrogen, phosphoric acid and potash is applied to one plat, and one element at a time in turn is left out of the fertilizer applied to the other plats. The average results of five such experiments performed in Clay, Hamilton, Harrison, Jackson and

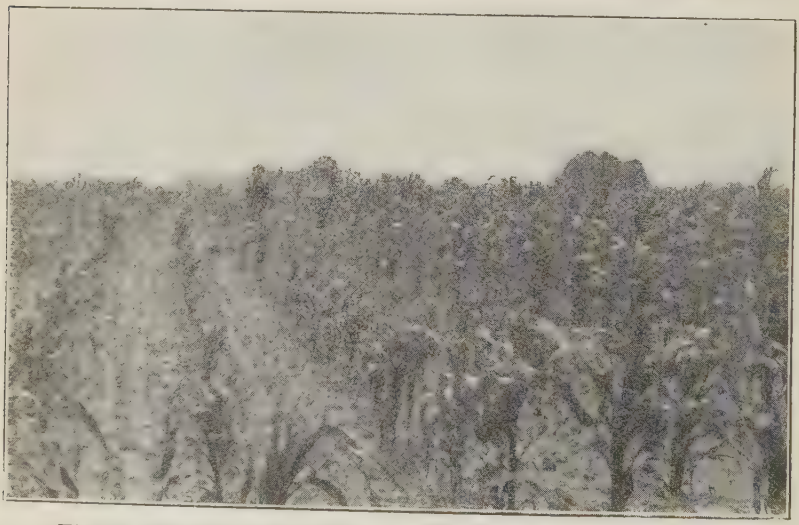


Fig. 5. Effect of fertilizer on a clay loam soil, Clinton county

Jennings counties are given in Table V following. For the purpose of calculation, corn was valued at 40 cents per bushel, nitrogen at 20 cents per pound, phosphoric acid at six cents per pound and potash at five cents per pound. In this table nitrogen, phosphoric acid and potash are indicated by N, P, and K, respectively.

TABLE V—Average Results of Representative Fertilizer Tests on Corn on Clay and Loam Soils

Fertilizer applied	Bus. per acre increase	Value of increase at 40 cts.	Cost of fertilizer	Profit per acre	Profit per dollar invested
N P K	9.50	$3.80	$1.95	$1.85	$0.94
P K	6.64	2.66	1.11	1.55	1.39
N K	3.48	1.39	1.09	0.30	0.28
N P	7.84	3.14	1.70	1.44	0.84
Calculated Effect and Value of Each Element, by Difference					
N	2.86	1.14	0.84	0.30	0.36
P	6.02	2.41	0.86	1.55	1.80
K	1.66	0.66	0.25	0.41	1.64

It is to be noted from the above table that it hardly paid to use nitrogen, but that phosphoric acid and potash each yielded a good profit. It is often argued that the use of a little commercial nitrogen in a corn fertilizer gives the corn a quick start in the spring and that for that reason it pays to use it, and as a matter of fact it does sometimes make the corn look a little better early in the season. The theory sounds plausible, but it does not agree with the average results of our field experiments, which show that whatever commercial nitrogen may have promised in the spring, it often fails to show a profit at harvest time, and the final result is the one that counts. It seems to be fully demonstrated that it usually does not pay to use nitrogen in corn fertilizer as well as it pays to spend the same amount of money for phosphoric acid or potash.

METHOD OF APPLICATION OF FERTILIZER

The results the Station has secured on methods of application indicate that drilling continuously in the row is probably the most effective method of applying small or medium amounts of fertilizer to corn. Applying the fertilizer in or very near the hill has been found to be unsafe, as such application frequently injures the germination of the seed and has a tendency to cause bad root development. Heavy applications should be made broadcast, in part at least.

UNPRODUCTIVE BLACK SOILS

In many places in the state, particularly in the northern and northwestern portions, are found black soils that are more or less unproductive. These may be divided into true peat or muck soils and unproductive sandy loam soil, locally known as "bogus," "alkali," etc.

The peat, or so called muck soils have been formed in the bottoms of former lakes or ponds from the mosses and other plants growing therein. These soils consist almost entirely of organic matter and will burn when dry. They are extremely loose in texture and unless very thoroughly drained, are inclined to be wet, as they usually occupy the lowest portion of the surrounding land.

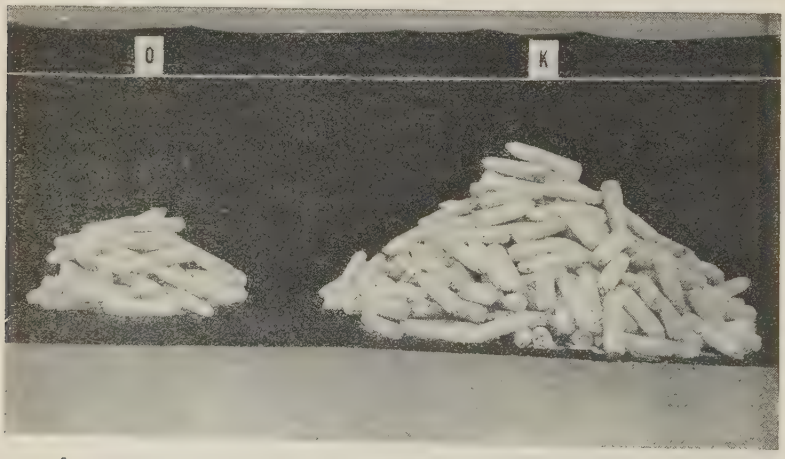


Fig. 6. Result of fertilizer test on muck soil, Starke county

No fertilizer
12 bus. per acre

200 pounds muriate of potash per acre
58 bus. per acre

During the last 15 or 20 years, the Station has conducted a large number of soil improvement experiments on these soils. As a result of this work, it has been found that peat or muck soils are almost invariably deficient in potash and usually the application of this element alone will cause marked increases in the yields of corn and other crops. Occasionally muck soils are found that are also deficient in phosphoric acid and it is usually a good plan to use some readily available phosphate on these soils, especially on corn, even though it does not have as great an effect in increasing the yield as potash, for the reason that phosphoric acid tends to hasten the ripening of the crop and to produce a better quality of grain.

It is best to make a heavy application of potash to muck soils for the reason that it is necessary to have enough present to not only grow stalks, but to insure the growth of the grain as well. Experiments conducted by the Station have shown that it is more profitable to use 200 pounds of muriate of potash per acre on these soils than 40 pounds per acre. The Station results show that no fear need be entertained of loss of potash by leaching from muck soils, and the same is also true in regard to phosphoric acid.

In the following table are given some typical results that have been secured in the fertilization of muck soils.

TABLE VI—Results of Corn Fertilization Experiments on Peat Soil

Yield per acre. One application of fertilizers only

Fertilizers applied per acre[1]	Starke Co.	Starke Co.	Henry Co.		Madison Co.		Newton Co.				General average
			1st yr.	2d yr.	1st yr.	2d yr.	1st yr.	2d yr.	3d yr.	4th yr.	
None	50	12	27	22	56	66	30	45	34	22	36.4
Muriate of potash, 200 lbs.	61	58	58	47	70	90	43	61	74	42	60.4
Muriate of potash, 200 lbs. / Acid phosphate, 300 lbs.	62	65	58	54	67	92	58	54	59	41	61.0
Dried blood, 100 lbs. / Acid phosphate, 300 lbs. / Muriate of potash, 200 lbs.	65	52	57	49	69	89	61	66	64	42	61.4

[1]In a few cases sulphate of potash and Banner Bone were used instead of muriate of potash and acid phosphate. In the Madison and Newton county experiments 1300 pounds of dried blood was used instead of 100 pounds

The fertilization recommended above for unproductive peat or muck soils is also suitable for unproductive black sandy loams, the so-called "bogus" or "alkali" soils, and generally gives equally satisfactory results, but the use of acid phosphate is generally more profitable than on peat, as it frequently increases the yield as well as improving the quality of the crop. Occasionally soils of this class are unproductive because of excessive acidity, and in such cases at least two tons per acre of finely ground limestone or slaked lime should be applied after breaking, and thoroughly harrowed in. Black sandy loams which are unproductive because of acidity, do not respond satisfactorily to the use of either manure or fertilizer and may be recognized by that characteristic. After lime has been

applied, phosphatic fertilization will frequently be found necessary, and in such cases the soil should be given about the same treatment as recommended for clay and loam soils.

SUMMARY OF SOIL TREATMENT RECOMMENDED

Grow clover before every corn crop, if possible, and then use the clover, or the manure it makes, to fertilize the corn. The nitrogen and organic matter left behind in the roots and stubble are not sufficient to maintain the necessary supply in the soil.

If clover fails, substitute soy beans or cow peas. They improve the soil in the same way the clover does. If you never tried either, write the Experiment Station for information.

Test your soil for acidity by applying slaked lime or finely ground limestone at the rate of two tons per acre on a small piece, before seeding to clover. If it does not improve the clover, the soil is not acid and it will probably not pay to use lime, but if it does, ime can be profitably used, and should be, for success with legumes is essential to the economical maintenance of soil fertility.

Feed as much of the produce of the farm as practicable and take good care to save the manure, both solid and liquid. Re-enforce every ton of manure with 40 pounds of acid or rock phosphate and use most of the manure on the corn. Crops generally need more phosphoric acid than the soil supplies, and manure contains only a little.

Use enough fertilizer for the wheat or oats so that there will be some left over for the clover and corn.

For land which has not been manured, drill in the corn row 200 pounds per acre of a fertilizer containing about 10 per cent. available phosphoric acid and 4 per cent. potash.

For peat or muck soils, the broadcast application once in three or four years of 200 pounds of muriate of potash per acre and the application in the row, each season at planting time, of about 100 pounds of acid phosphate is recommended. The use of nitrogen is not profitable on these soils, as they are already abundantly supplied with that element.

CORN INSECTS

JAMES TROOP, Entomologist

There are many species of insects which attack corn in one form or another, some feeding upon the roots, others on the stems and leaves and still others attacking the grain. The life histories of most of these species have been pretty definitely worked out and remedies prescribed which are more or less successful, according to the way they are administered. Owing to the fact that the corn crop in the middle west usually covers such a large territory, the common methods of dealing with insects by the application of poisonous solutions with the spray pump are not only impractical, but in many cases impossible. For example, those species which feed upon the roots of the corn plant are, in most cases, entirely beyond the reach of insecticides, other than repellants. Hence, the remedies generally recommended for these species consist for the most part in shifting the common methods of general farm practice, so as to interfere as much as possible with their natural habits of feeding and breeding.

Generally speaking, one of the most important factors in dealing with insects of this nature is a well planned *rotation of crops*. The farmer who practices a systematic rotation, not growing any crop two years in succession, will suffer much less from injurious insects than will the farmer who specializes in one or two crops. As their favorite food plants are shifted frequently to new ground, they do not have sufficient time to accumulate to any great extent. On the other hand, allowing the land to remain in sod for a number of years furnishes a fine breeding ground for such insects as the white-grub, wire-worms, cut-worms, etc. The effectiveness of crop rotation is well illustrated in the cas of the corn root-worm, which is strictly a corn insect. Those who practice growing corn after corn for a number of years in succession, will suffer more or less from the attacks of this insect. Such other measures as changing the time of planting, early or late fall plowing, clean culture and burning up of weeds and trash, are all more or less effective, according to the particular case to be dealt with.

The different species of cut-worms pass the winter in the larval stage, coming out in the spring after their long fast to begin their feeding with renewed vigor. This is kept up until June or a little later, when they become full grown and change to the pupa stage. Where they are known to be present in troublesome numbers, they may be largely avoided by delaying the planting for a couple of

weeks, as they will then have nearly completed their growth before the corn is sufficiently developed for them to feed upon it. For infested sod ground, another remedy is late plowing, thus turning under a quantity of green stuff which furnishes food for the worms until they become full grown.

Such species as the wire-worm and corn ear-worm go into the ground to pass the winter in the larva or pupa state. Fall plowing will expose many of these insects to the birds, or their winter quarters will be so broken up that they will be unable to re-establish themselves and so will perish. Others will be buried so deeply that they will be unable to work their way out in the spring.

The development of the corn root-louse in destructive numbers



Fig. 7. Effect of fertilizer in overcoming injury from root lice Unfertilized in foreground, fertilized in background

is largely due to ants, hence remedial measures must be largely directed against the latter. By late fall plowing, after the ants have gone into their winter quarters, their nests will be broken up and they will be unable to re-establish themselves before winter sets in.

Such insects as the army-worm and chinch-bug pass the winter in dead grass and various other rubbish which afford them protection. By burning over waste places just before winter sets in, many of them will be destroyed.

As regular farm practices, late planting, late spring and early

fall plowing, can hardly be recommended, but in bad cases they may have to be resorted to. It is better by far to avoid such trouble by constant care to prevent the conditions which favor the development of the insects in the first place. To be effective, the whole neighborhood must cooperate in measures of this kind.

The practice of crop rotation, keeping the land free of weeds and trash of all kinds, late fall plowing of infested lands, and properly nourishing the corn plant, are about the only practical preventive or remedial measures that can be applied. To what extent the effectiveness of certain fertilizers is due to their action as repellants has not been definitely determined, but the application of manures and fertilizers which produce vigorous growth will at least help the plants to withstand the injury. This is well illustrated in Fig. 9, which shows a field badly infested with plant lice. The corn in the foreground, which was not fertilized, has seriously suffered, while the corn seen in the background, which was fertilized, has managed to make a good development in spite of the insects.

CORN SMUT

A. G. Johnson, Assistant Botanist

Corn smut is present more or less throughout the state and in some cases produces considerable losses.

NATURE OF THE DISEASE

Corn smut is a disease caused by a specific fungus. This fungus has the ability of attacking any growing part of the corn plant with which its spores (the smut dust) may come in contact, the fresh tassels, the young ears, the green leaves and stalks. The spores of the fungus live over winter in the old smut masses left in the cornfield or near by, and the following early summer are carried by the wind to any corn growing near by, and there reproduce the disease. The characteristic, perverted growths caused, (the smut masses), are at first whitish but soon turn grayish, then black and become changed to masses of black dust, the spores of the fungus. These spores are distributed by the wind, and may infect other plants of growing corn from time to time the same season, or may live over winter on the ground in the fields or near by, ready to infect the subsequent corn crop.

CONTROL OF THE DISEASE

From the habits of the fungus causing the disease it is clear that no seed treatment would be of any service. The disease is not carried over from year to year on the seed. Treating the seed does not prevent corn smut. The fungus causing the disease is carried from one year to the next by the old smut masses lying in the fields or near by, ready to attack the new crop of corn, to which it is borne by the wind.

Corn smut can be entirely eradicated, or at least reduced to a minimum, by gathering the smut masses and destroying them. In practice, it has been found best to go through the fields once or twice during the growing season and gather all smut balls, both young and mature, and again at husking time to collect any that may then be found. These should be completely destroyed by burning or burying. Boys, or other cheap labor, can usually be employed for the work. Although the loss from smut rarely rises to as much as five per cent., yet in practice, it has been found that this method of destroying it much more than pays for itself, and does so even if scarcely one per cent. is present. When smut is cleared from a farm or its vicinity, it will be slow to appear again.

In ordinary amounts it is not injurious to animals.



Fig. 8. Corn smut on stalk and leaves



Fig. 9. Corn smut on the ear

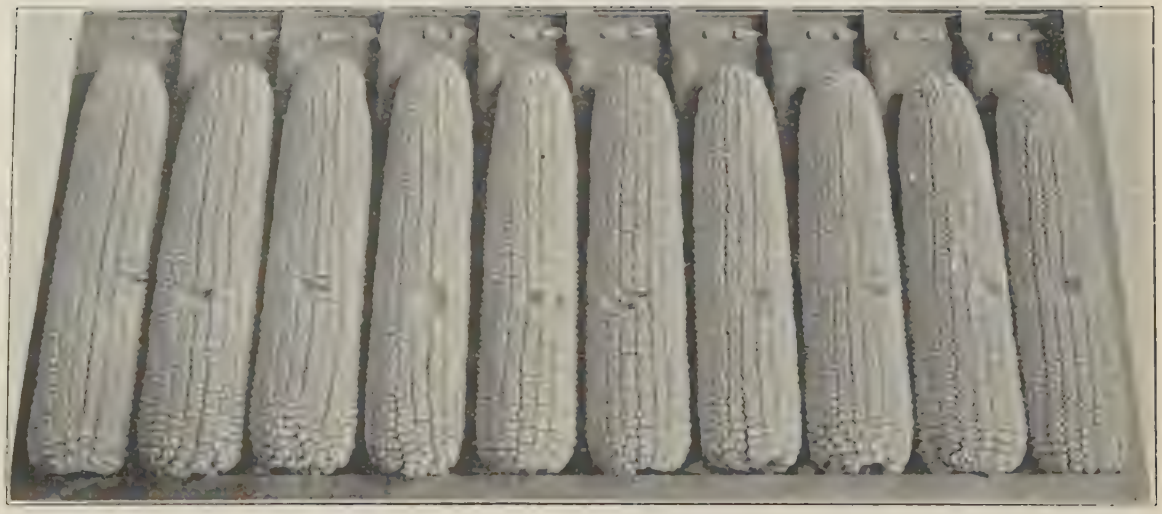


Fig. 10. A fine lot of seed ears of good quality

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 26

LaFayette, Ind., April, 1911

AGRICULTURAL EXTENSION

X

MILK PRODUCTION

IV

COMPUTING RATIONS FOR DAIRY COWS

O. F. Hunziker

O. E. Reed

PURPOSE

One of the principal causes of the low average milk and butter production throughout the state of Indiana is the lack of knowledge of how to properly feed the dairy cow. No matter how well bred a cow may be, or how closely she may conform to the dairy type, if she is not fed and cared for properly she will not make a profitable producer. It is essential that records of production be kept of each cow by weighing the milk and testing it for butter fat regularly. Every successful dairyman must do this in some way, but it is equally important to see that the herd is fed the proper kind and amounts of feed.

There is and has been during more recent years an increasing demand for information regarding balanced rations for dairy cows. The Experiment Station is constantly receiving inquiries regarding

the balanced ration. In a great many cases, a list of available feeds is mentioned and suggestions for a combination of these feeds to form a balanced ration are desired. The agricultural press of the country is flooded with similar inquiries.

It is the purpose of this publication to present tables and data in a simplified form to encourage the cow owners to give more attention to the feeding of their cows by being able to work out and formulate rations for themselves.

KIND AND VALUE OF FOOD NUTRIENTS CONTAINED IN FEEDING STUFFS

The various substances contained in the feeding stuffs used to build up and maintain the animal body and to produce milk may be divided into four classes: water, ash, fat and carbohydrates, and protein. All feeding stuffs contain these substances in varying amounts.

The water contained in the feeds is used for the same purpose as water that is drunk by the animal and has no food value.

The ash is what is left after the combustible part of a feeding stuff is burned away. It is used by the animal principally to make bone, hence it is important that the ration fed to young stock be well supplied with ash. Most combinations of feed, however, contain an abundance of ash.

The carbohydrates and fat supply the heat to keep the animal body warm, produce fat to be stored up in the body and butter fat in the milk, and furnish energy to keep up the bodily functions. The carbohydrates are present in nearly all grains such as corn, wheat, oats, etc., in the form of starch. In some grains and plants they are also found in the form of sugars. Fat is found to some extent in all grains; it is used for the same purpose as carbohydrates but is two and one-fourth times as valuable as carbohydrates.

The protein in the food is used in the animal body to make muscle, bone, hair, horn, hoof, blood and milk. The casein or curd in milk is largely composed of this substance. All of the common feeds contain some protein, some feeds contain a very large per cent. and others a smaller amount. The oil meals, and like by-products contain a high per cent. of protein. While other substances can not be used to take its place in the ration, protein can be used in the place of carbohydrates and fat. The efficiency of carbohydrates and fat, as compared with protein for energy, is practically the same. The protein is more expensive than the carbohydrates and fat. For the sake of economy, therefore, only that amount of protein should be supplied that will suffice to repair the

body machinery and to furnish nutrients for milk production. For a ration to be balanced, it must contain these substances in the proportion in which they are needed by the animal.

AMOUNT OF FOOD NUTRIENTS REQUIRED

By actual experiment and trial, it has been determined how much of these nutrients is required to maintain the body of the animal. This amount of nutrients thus required is called the ration of maintenance. By the ration of maintenance, we mean, that amount of feed which is required to keep up the life processes, and the repair of the body. This is a fixed charge and the animal must receive this amount of food before we can expect any returns. The food, used for milk production by the cow, is that amount given in addition to the amount required for maintenance. Experiments have shown that the following amounts of nutrients are required to maintain a 1000 pound cow for one day.

TABLE I

	Protein lbs.	Carbohydrates lbs.	Fat lbs.
Daily maintenance per 1000 lbs. live weight	.7	7.0	.1
Daily maintenance per 100 lbs. live weight	.07	.70	.01

It has also been determined by experimental trial how much of the several nutrients are required for the production of a pound of milk at a given per cent. of fat. The following table (Haecker) sets forth the amounts of each nutrient required to produce a pound of milk of a given richness.

TABLE II

For milk testing per cent. fat	Protein lbs.	Carbohydrates lbs.	Fat lbs.
3.0	.042	.19	.013
3.5	.045	.21	.015
4.0	.048	.23	.016
4.5	.051	.25	.018
5.0	.054	.27	.019
5.5	.067	.29	.020
6.0	.060	.31	.022

With the above facts at hand, it is an easy matter to figure out the nutrients required by a cow of a given weight and producing a definite quantity of milk.

From chemical analysis and digestion experiments carried on with different animals, we know the amount and digestibility of the nutrients in the various feeding stuffs. Tables in Henry's "Feeds and Feeding" give the pounds of digestible nutrients in our common feeds in a very simplified form.

BALANCING THE RATION

Knowing the requirements of the animals and with the help of the table giving the nutrients contained in the feeding stuffs, we are now prepared to balance a ration; for example, we will work out a definite problem.

Problem. Farmer *A* has a dairy cow that weighs 1000 pounds and is giving 30 pounds of milk per day, which tests 5 per cent. butter fat. He has the following feeds on hand: clover hay, corn silage, corn meal, bran and cotton seed meal. Make up a ration for this cow.

The first step in working out this ration is to figure out the nutrients required by this cow. From Table I, we find that it requires .07 pound of protein, .7 pound carbohydrates and .01 pounds of fat for maintenance of 100 pounds live weight; then it would require ten times this amount for a 1000 pounds cow or .7 pounds protein, 7 pounds carbohydrates and .1 pound of fat. According to Table II it requires .054 pound of protein, .27 pound of carbohydrates and .019 pound of fat for one pound of 5 per cent. milk; for 30 pounds, the requirements are thirty times these amounts or 1.62 pounds of protein, 8.1 pounds of carbohydrates and .057 pound of fat. The total nutrients required, are shown in the following table.

TABLE III

	Protein lbs.	Carbohydrates lbs.	Fat lbs.
Maintenance	.7	7.0	.1
For 30 lbs. milk	1.62	8.1	.57
Total nutrients required	2.32	15.1	.67

ROUGHAGE THE BASIS OF THE RATION

In working up a ration for a dairy cow, we should always begin with the roughage. It would be possible to make up the required nutrients for this animal without using any hay or other roughage whatever, but the cow would not be satisfied. The cow must have her paunch full to be satisfied, so we must fill her up with what roughage she wants. We should always keep in mind to furnish feeds that are palatable. A ration could be made up of corn stalks and oak leaves but it would not be palatable enough for the cow to consume a sufficient quantity of it to satisfy her. In general, a cow, when fed hay alone for roughage, will eat two pounds of hay per day for each hundred pounds of live weight. When other roughage is fed, in addition to hay, such as silage or other succulent food, about half this amount will be consumed.

In the above problem, we have given both hay and silage for roughage. A cow in full milk, and weighing about 1000 pounds will consume about 10 pounds of hay and 40 pounds of silage per day. On consulting Table III, giving the digestible nutrients in the feeding stuffs, we find the hay and silage to contain the following amounts of digestible nutrients.

TABLE IV

	Protein lbs.	Carbohydrates lbs.	Fat lbs.
10 lbs. clover hay	.680	3.58	.170
40 lbs. corn silage	.360	4.52	.280
Total	1.040	8.10	.450

GRAIN FEED NEEDED TO SUPPLY SHORTAGE OF FOOD NUTRIENTS

It is noticed that the hay and silage furnish about one-half of the required nutrients; it might also be mentioned that hay and silage furnish nutrients in abundance for maintenance requirement; by this we know that hay and silage are sufficient for a cow when not giving milk. By subtracting the nutrients furnished by the hay and silage from the total amount of nutrients required, we obtain the exact amount of nutrients that must be furnished in the grain ration.

TABLE V

	Protein lbs.	Carbohydrates lbs.	Fat lbs.
Nutrients required	2.32	15.10	.67
Nutrients in hay and silage	1.04	8.10	.450
Difference	1.28	7.00	.19

It requires a little training and experience with the different grain feeds to know just how much of each food to use; this comes by practice.

In this problem, we have available corn meal, bran and cottonseed meal. Suppose we calculate the digestible nutrients in the feeds used in the proportion of four pounds corn, three pounds bran, and one pound cottonseed meal. From Table III, giving the digestible nutrients, we obtain the following figures.

TABLE VI

Kinds of feeds	Lbs.	Protein lbs.	Carbohydrates lbs.	Fat lbs.
Corn	4	.316	2.668	.172
Bran	3	.387	1.203	.102
Cottonseed meal	1	.372	.169	.122
Total	8	1.075	4.040	.396

It is noticed that this ration does not contain quite enough nutrients. It is particularly deficient in protein. By adding one half pound of cottonseed meal, we find that it practically makes up the required nutrients. On making this addition, we have a total of 1.1261 pounds of protein, 4.125 pounds of carbohydrates and .457 pound of fat in the grain ration. Now add the nutrients contained in the roughage to those contained in the grain feed. This represents the total nutrients contained in the whole ration. Table VII shows the total nutrients required by the animal and the total nutrients contained in the ration.

TABLE VII

Kinds of feeds	Protein lbs.	Carbohydrates lbs.	Fat lbs.
Hay and silage	1.04	8.10	.450
Grain ration	1.261	4.125	.457
Total daily ration	2.301	12.225	.907
Total requirements	2.32	15.1	.67

This comparison shows at a glance that the ration contains enough protein, is somewhat deficient in carbohydrates, but contains an excess of fat. As stated before, the fat is used for the same purpose as the carbohydrates and is equal to two and one-fourth times as much as the carbohydrates. With the excess of fat figured in terms of carbohydrates, there is practically enough carbohydrates in the ration to meet the requirements of this animal.

In case several feeds are to be used in a grain ration, a better system of figuring the ration and one that will simplify the feeding, is to compound a mixture of the different feeds; calculate the nutrients contained in one pound of this mixture, then feed the grain ration according to milk production. Where this can be done, the rule of feeding one pound of such a mixture per day for each three pounds of milk per day, works very well. If the record of butter fat is known, a better rule to go by, is to feed one pound of grain per day for each pound of butter fat produced per week. A heifer should always be fed a little heavier, since she must have food for growth. In case the grain ration consists of only one feed, such as cottonseed meal, or other highly concentrated food stuff, the above rules can not be used.

For example, we will use the figures given in the problem and make up a ration to be fed in this way. This ration we can make as follows:

TABLE VIII

Kinds of feeds	Lbs.	Protein lbs.	Carbohydrates lbs.	Fat lbs.
Corn	4	.316	2.668	.172
Bran	2	.258	.802	.068
Cottonseed meal	1	.372	.169	.122
Nutrients contained in one lb.		.135	.519	.0517

In feeding a pound of grain for each three pounds of milk, this cow would require 10 pounds of the above mixture per day. This should be fed in addition to all the roughage the cow will consume. The roughage could be consistently figured at 10 pounds of hay and 40 pounds of silage. On tabulating this ration we have:

TABLE IX

	Protein lbs.	Carbohydrates lbs.	Fat lbs.
10 lbs. clover hay	.680	3.580	.170
40 lbs. silage	.360	4.520	.280
10 lbs. grain ration	1.350	5.190	.517
Total	2.390	13.290	.967
Nutrients required	2.32	15.1	.640

Here again, we have practically the same nutrients in the daily ration as the requirements of the animal call for.

SHOULD FEED AN ECONOMICAL RATION

Some foods will furnish a certain substance at a very much lower cost than others. The carbohydrates can best be had by using corn. Corn contains a high per cent. of carbohydrates and is our principal grain crop. The protein can be furnished at a lower cost through the roughage. Grain foods containing a high per cent. of protein are expensive and usually have to be purchased. By feeding such hays as clover, cowpea, and alfalfa, most of the required protein can be furnished at a low cost since it can be grown on the farm. With high producing cows, it will be necessary to feed, at least, a small amount of some grain feed containing a high per cent. of protein. When buying feed to supply the protein in a ration, one should buy the feed that contains the highest per cent. of protein, provided it is a palatable feed and is safe to feed.

FIGURING THE COST OF THE DAILY RATION

By the use of the following tables, it is a very easy matter to figure the cost of the daily ration. For example, the cost of the ration which was balanced in the circular is computed in Table X.

TABLE X

	Feed amount lbs.	Value dollars	Cost per day cents
Corn	4	.50 per bu.	3.37
Bran	3	24.00 " ton	3.60
Cottonseed meal	1.5	32.00 " "	2.40
Clover hay	10	10.00 " "	5.0
Corn silage	40	3.00 " "	6.0
Total cost per day			20.37

Figuring at the above prices, this cow, giving 30 pounds of 5 per cent. milk or about one and one half pounds of butter fat per day, consumes 20 cents worth of feed. At the average price paid for butter fat during the past year (1910), it is worth about 45 cents. The skim milk is left on the farm for calves or hogs, and the manure, if handled properly and applied to the land, will pay for the labor. This is a very economical ration considering the profit as given above and the fact that the farm crops are marketed on the farm at a retail price. It is possible to formulate rations that will furnish the same nutrients as given in this ration at a lower cost.

Table XI—Giving Cost of One Pound at a Given Price Per Ton

Price of 1 ton	Cost of 1 lb.	Price of 1 ton	Cost of 1 lb.	Price of 1 ton	Cost of 1 lb.	Price of 1 ton	Cost of 1 lb.	Price of 1 ton	Cost of 1 lb.	Price of 1 ton	Cost of 1 lb.
Dollars	Cents	Dollars	Cents	Dollars	Cents	Dollars	Cents	Dollars	Cents	Dollars	Cents
.25	.0125	.57	.0285	.89	.0445	6.25	.3125	14.25	.712	22.25	1.112
.26	.0130	.58	.0290	.90	.0450	6.50	.3250	14.50	.725	22.50	1.125
.27	.0135	.59	.0295	.91	.0455	6.75	.3375	14.75	.737	22.75	1.137
.28	.0140	.60	.0300	.92	.0460	7.00	.3500	15.00	.750	23.00	1.150
.29	.0145	.61	.0305	.93	.0465	7.25	.3625	15.25	.762	23.25	1.162
.30	.0150	.62	.0310	.94	.0470	7.50	.3750	15.50	.775	23.50	1.175
.31	.0155	.63	.0315	.95	.0475	7.75	.3875	15.75	.787	23.75	1.187
.32	.0160	.64	.0320	.96	.0480	8.00	.4000	16.00	.800	24.00	1.200
.33	.0165	.65	.0325	.97	.0485	8.25	.4125	16.25	.812	24.25	1.212
.34	.0170	.66	.0330	.98	.0490	8.50	.4250	16.50	.825	24.50	1.225
.35	.0175	.67	.0335	.99	.0495	8.75	.4375	16.75	.837	24.75	1.237
.36	.0180	.68	.0340	1.00	.0500	9.00	.4500	17.00	.850	25.00	1.250
.37	.0185	.69	.0345	1.25	.0625	9.25	.4625	17.25	.862	25.25	1.262
.38	.0190	.70	.0350	1.50	.0750	9.50	.4750	17.50	.875	25.50	1.275
.39	.0195	.71	.0355	1.75	.0825	9.75	.4875	17.75	.887	25.75	1.287
.40	.0200	.72	.0360	2.00	.1000	10.00	.5000	18.00	.900	26.00	1.300
.41	.0205	.73	.0365	2.25	.1125	10.25	.5125	18.25	.912	26.25	1.312
.42	.0210	.74	.0370	2.50	.1250	10.50	.5250	18.50	.925	26.50	1.325
.43	.0215	.75	.0375	2.75	.1375	10.75	.5375	18.75	.937	26.75	1.337
.44	.0220	.76	.0380	3.00	.1500	11.00	.5500	19.00	.950	27.00	1.350
.45	.0225	.77	.0385	3.25	.1625	11.25	.5625	19.25	.962	27.25	1.362
.46	.0230	.78	.0390	3.50	.1750	11.50	.5750	19.50	.975	27.50	1.375
.47	.0235	.79	.0395	3.75	.1875	11.75	.5875	19.75	.987	27.75	1.387
.48	.0240	.80	.0400	4.00	.2000	12.00	.6000	20.00	1.000	28.00	1.400
.49	.0245	.81	.0405	4.25	.2125	12.25	.6125	20.25	1.012	28.25	1.412
.50	.0250	.82	.0410	4.50	.2250	12.50	.6250	20.50	1.025	28.50	1.425
.51	.0255	.83	.0415	4.75	.2375	12.75	.6375	20.75	1.037	28.75	1.437
.52	.0260	.84	.0420	5.00	.2500	13.00	.6500	21.00	1.050	29.00	1.450
.53	.0265	.85	.0425	5.25	.2625	13.25	.6625	21.25	1.062	29.25	1.462
.54	.0270	.86	.0430	5.50	.2750	13.50	.6750	21.50	1.075	29.50	1.475
.55	.0275	.87	.0435	5.75	.2875	13.75	.6875	21.75	1.087	29.75	1.487
.56	.0280	.88	.0440	6.00	.3000	14.00	.7000	22.00	1.100	30.00	1.500

TABLE XII—GIVING COST OF ONE POUND AT A GIVEN PRICE AND WEIGHT PER BUSHEL

	When a bushel weighs									
	32 lbs.	42 lbs.	46 lbs.	48 lbs.	50 lbs.	52 lbs.	56 lbs.	58 lbs.	60 lbs.	70 lbs.
	1 lb. costs	1 lb. costs	1 lb. costs	1 lb. costs	1 lb. costs	1 lb. costs	1 lb. costs	1 lb. costs	1 lb. costs	1 lb. costs
Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
10	.312	.237	.217	.208	.20	.192	.178	.172	.167	.143
11	.344	.262	.239	.229	.22	.212	.196	.189	.183	.157
12	.375	.286	.261	.250	.24	.231	.214	.207	.200	.171
13	.406	.309	.283	.271	.26	.250	.232	.224	.217	.186
14	.437	.333	.304	.292	.28	.269	.250	.241	.233	.200
15	.469	.357	.326	.312	.30	.288	.268	.259	.250	.214
16	.500	.381	.348	.333	.32	.308	.286	.276	.267	.228
17	.531	.405	.369	.354	.34	.327	.304	.293	.283	.243
18	.562	.428	.391	.375	.36	.346	.321	.310	.300	.257
19	.594	.452	.413	.396	.38	.365	.339	.327	.317	.271
20	.625	.476	.435	.417	.40	.385	.357	.345	.333	.286
21	.656	.500	.456	.437	.42	.404	.375	.362	.350	.300
22	.687	.524	.478	.458	.44	.423	.393	.379	.367	.314
23	.719	.547	.500	.479	.46	.442	.411	.396	.383	.328
24	.750	.571	.522	.500	.48	.461	.428	.414	.400	.343
25	.781	.595	.544	.521	.50	.481	.446	.431	.417	.357
26	.812	.619	.565	.542	.52	.500	.464	.448	.433	.371
27	.844	.643	.587	.563	.54	.519	.482	.465	.450	.386
28	.875	.667	.609	.583	.56	.538	.500	.483	.467	.400
29	.906	.690	.630	.604	.58	.558	.518	.500	.483	.414
30	.937	.714	.652	.625	.60	.577	.536	.517	.500	.428
31	.969	.738	.674	.646	.62	.596	.554	.534	.517	.443
32	1.000	.762	.696	.667	.64	.615	.571	.552	.533	.457
33	1.031	.787	.717	.687	.66	.635	.589	.569	.555	.471
34	1.062	.809	.739	.708	.68	.654	.607	.586	.567	.486

TABLE XII—GIVING COST OF ONE POUND AT A GIVEN PRICE AND WEIGHT PER BUSHEL (Continued)

	When a bushel weighs									
	32 lbs.	42 lbs.	46 lbs.	48 lbs.	50 lbs.	52 lbs.	56 lbs.	58 lbs.	60 lbs.	70 lbs.
	1 lb. costs	1 lb. costs	1 lb. costs	1 lb. costs	1 lb. costs	1 lb. costs	1 lb. costs	1 lb. costs	1 lb. costs	1 lb. costs
Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
35	1.094	.833	.761	.729	.70	.673	.625	.603	.583	.500
36	1.125	.857	.783	.750	.72	.692	.643	.620	.600	.514
37	1.156	.881	.804	.771	.74	.711	.661	.638	.617	.528
38	1.187	.905	.826	.792	.76	.731	.678	.655	.633	.543
39	1.219	.928	.848	.812	.78	.750	.696	.672	.650	.557
40	1.250	.952	.869	.833	.80	.769	.714	.689	.667	.571
41	1.281	.976	.891	.854	.82	.788	.732	.707	.683	.586
42	1.312	1.000	.913	.875	.84	.808	.750	.724	.700	.600
43	1.344	1.024	.935	.896	.86	.827	.768	.741	.717	.614
44	1.375	1.048	.956	.917	.88	.846	.786	.759	.733	.628
45	1.406	1.071	.978	.937	.90	.865	.804	776	.750	.643
46	1.437	1.095	1.000	.958	.92	.884	.821	.793	.767	.657
47	1.469	1.119	1.022	.979	.94	.904	.839	.810	.783	.671
48	1.500	1.143	1.043	1.000	.96	.923	.857	.827	.800	.686
49	1.531	1.167	1.065	1.021	.98	.942	.875	.845	.817	.700
50	1.562	1.190	1.087	1.042	1.00	.961	.893	.862	.833	.714
51	1.594	1.214	1.109	1.062	1.02	.981	.911	.879	.850	.728
52	1.625	1.238	1.130	1.083	1.04	1.000	.928	.896	.867	.743
53	1.656	1.262	1.152	1.104	1.06	1.019	.946	.913	.883	.757
54	1.687	1.286	1.174	1.125	1.08	1.038	.964	.931	.900	.771
55	1.719	1.309	1.196	1.146	1.10	1.058	.982	.948	.917	.786
56	1.750	1.333	1.217	1.167	1.12	1.077	1.000	.965	.933	.800
57	1.781	1.357	1.239	1.187	1.14	1.096	1.018	.983	.950	.814
58	1.812	1.381	1.261	1.208	1.16	1.115	1.036	1.000	.967	.828
59	1.844	1.405	1.283	1.229	1.18	1.134	1.054	1.017	.983	.843
60	1.875	1.428	1.304	1.250	1.20	1.154	1.071	1.034	1.000	.857

TABLE XIII—GIVING POUNDS OF DRY MATTER AND DIGESTIBLE NUTRIENTS CONTAINED IN A GIVEN NUMBER OF POUNDS OF FOOD STUFF

Lbs.	CORN				CORN AND COB MEAL				OATS			
	Composition				Composition				Composition			
	Dry matter	Digestible			Dry matter	Digestible			Dry matter	Digestible		
		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat
1	.89	.079	.667	.043	.85	.044	.60	.029	.89	.092	.473	.042
2	1.78	.158	1.334	.086	1.70	.088	1.20	.058	1.78	.184	.946	.084
3	2.67	.237	2.001	.129	2.55	132	1.80	.087	2.67	.276	1.419	.126
4	3.56	.316	2.668	.172	3.40	.176	2.40	.116	3.56	.368	1.892	.168
5	4.45	.395	3.335	.215	4.24	.220	3.00	.145	4.45	.460	2.365	.210
6	5.35	.474	4.002	.258	5.09	.264	3.60	.174	5.34	.552	2.838	.252
7	6.24	.553	4.669	.301	5.94	.308	4.20	.203	6.23	.644	3.311	.294
8	7.13	.632	5.336	.344	6.79	.352	4.80	.232	7.13	.736	3.784	.336
9	8.02	.711	6.003	.387	7.64	.396	5.40	.261	8.01	.828	4.257	.378
10	8.91	.790	6.670	.430	8.49	.440	6.00	.290	8.90	.920	4.730	.420

Lbs.	BARLEY				RYE				WHEAT			
1	.89	.087	.656	.016	.88	.099	.676	.011	.89	.105	.692	.017
2	1.78	.174	1.312	.032	1.77	.198	1.352	.022	1.79	.210	1.384	.034
3	2.67	.261	1.968	.048	2.65	.297	2.028	.033	2.68	.315	2.076	.051
4	3.56	.348	2.624	.064	3.54	.396	2.704	.044	3.58	.420	2.768	.068
5	4.45	.435	3.280	.080	4.42	.495	3.380	.055	4.47	.525	3.460	.085
6	5.35	.522	3.936	.096	5.30	.594	4.056	.066	5.37	.630	4.152	.102
7	6.24	.609	4.592	.112	6.19	.693	4.732	.077	6.28	.735	4.844	.119
8	7.13	.696	5.248	.128	7.07	.792	5.408	.088	7.16	.840	5.536	.136
9	8.02	.783	5.904	.144	7.96	.891	6.084	.099	8.05	.945	6.228	.153
10	8.91	.870	6.560	.160	8.84	.990	6.760	.110	8.95	1.050	6.920	.170

TABLE XIII—GIVING POUNDS OF DRY MATTER AND DIGESTIBLE NUTRIENTS CONTAINED IN A GIVEN NUMBER OF POUNDS OF FOOD STUFF (Continued)

LBS.	BRAN				SHORTS				BREWERS' GRAINS, DRIED			
	COMPOSITION				COMPOSITION				COMPOSITION			
	Dry matter	DIGESTIBLE			Dry matter	DIGESTIBLE			Dry matter	DIGESTIBLE		
		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat
1	.88	.129	.401	.034	.88	.122	.50	.038	.92	.157	.363	.051
2	1.77	.258	.802	.068	1.76	.244	1.00	.076	1.84	.314	.726	.102
3	2.65	.387	1.203	.102	2.65	.366	1.50	.114	2.75	.471	1.089	.153
4	3.54	.516	1.604	.136	3.53	.488	2.00	.152	3.67	.628	1.452	.204
5	4.42	.645	2.005	.170	4.41	.610	2.50	.190	4.59	.785	1.815	.255
6	5.31	.774	2.406	.204	5.29	.732	3.00	.228	5.51	.942	2.178	.306
7	6.19	.903	2.807	.238	6.17	.854	3.50	.266	6.43	1.099	2.541	.357
8	7.08	1.032	3.208	.272	7.05	.976	4.00	.304	7.34	1.256	2.904	.408
9	7.96	1.161	3.609	.306	7.94	1.098	4.50	.342	8.26	1.413	3.267	.459
10	8.85	1.290	4.010	.340	8.82	1.220	5.00	.380	9.18	1.570	3.630	.510

LBS.	COTTONSEED MEAL				LINSEED OIL MEAL (O. P.)				GERM OIL MEAL			
1	.92	.372	.169	.122	.91	.293	.327	.078	.90	.202	.445	.088
2	1.84	.744	.338	.244	1.82	.586	.654	.146	1.80	.404	.890	.176
3	2.76	1.116	.507	.366	2.72	.879	.981	.214	2.70	.606	1.335	.264
4	3.67	1.488	.676	.488	3.63	1.172	1.308	.282	3.60	.808	1.780	.352
5	4.59	1.860	.845	.610	4.54	1.465	1.635	.350	4.50	1.010	2.225	.440

LBS.	GLUTEN FEED				GLUTEN MEAL				WHEAT MIDDLINGS			
1	.90	.233	.507	.027	.88	.321	.412	.025	.879	.128	.530	.034
2	1.80	.466	1.014	.054	1.76	.642	.824	.050	1.758	.256	1.060	.068
3	2.70	.699	1.521	.081	2.64	.963	1.236	.075	2.637	.384	1.590	.102
4	3.60	.932	2.028	.108	3.52	1.284	1.648	.100	3.516	.512	2.120	.236
5	4.50	1.165	2.535	.135	4.40	1.605	2.060	.125	4.395	.640	2.650	.270

TABLE XIII—GIVING POUNDS OF DRY MATTER AND DIGESTIBLE NUTRIENTS CONTAINED IN A GIVEN NUMBER OF POUNDS OF FOOD STUFF (Continued)

LBS.	COWPEA HAY				OAT HAY				SOJA BEAN HAY			
	COMPOSITION				COMPOSITION				COMPOSITION			
	Dry matter	DIGESTIBLE			Dry matter	DIGESTIBLE			Dry matter	DIGESTIBLE		
		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat
5	4.465	.540	1.930	.055	4.55	.215	2.320	.075	4.43	.540	1.935	.075
6	5.358	.648	2.316	.066	5.47	.258	2.784	.090	5.32	.648	2.322	.090
7	6.251	.756	2.702	.077	6.38	.301	3.248	.105	6.21	.756	2.709	.105
8	7.144	.864	3.088	.088	7.29	.344	3.712	.120	7.10	.864	3.096	.120
9	8.037	.972	3.474	.099	8.20	.387	4.176	.135	7.98	.972	3.483	.135
10	8.930	1.080	3.860	.110	9.11	.430	4.640	.150	8.87	1.080	3.870	.150
11	9.823	1.188	4.246	.121	10.02	.473	5.104	.165	9.76	1.188	4.257	.165
12	10.716	1.296	4.632	.132	10.93	.516	5.568	.180	10.64	1.296	4.644	.180
13	11.609	1.404	5.018	.143	11.84	.559	6.032	.195	11.53	1.404	5.031	.195
14	12.502	1.512	5.404	.154	12.75	.602	6.496	.210	12.42	1.512	5.418	.210
15	13.395	1.620	5.790	.165	13.66	.645	6.960	.225	13.30	1.620	5.805	.225
16	14.288	1.728	6.176	.176	14.58	.688	7.424	.240	14.19	1.728	6.192	.240
17	15.181	1.836	6.562	.187	15.49	.731	7.888	.255	15.08	1.836	6.579	.255
18	16.054	1.952	6.948	.198	16.40	.774	8.352	.270	15.97	1.944	6.966	.270
19	16.967	2.061	7.334	.209	17.31	.817	8.816	.285	16.85	2.052	7.353	.285
20	17.860	2.160	7.720	.220	18.22	.860	9.280	.300	17.74	2.160	7.740	.300

TABLE XIII—GIVING POUNDS OF DRY MATTER AND DIGESTIBLE NUTRIENTS CONTAINED IN A GIVEN NUMBER OF POUNDS OF FOOD STUFF (Continued)

LBS.	ALFALFA HAY				ALSIKE HAY				RED CLOVER HAY			
	COMPOSITION				COMPOSITION				COMPOSITION			
	Dry matter	DIGESTIBLE			Dry matter	DIGESTIBLE			Dry matter	DIGESTIBLE		
		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat
5	4.58	.55	1.980	.060	4.51	.420	2.125	.075	4.23	.340	1.790	.085
6	5.50	.66	2.376	.072	5.42	.504	2.550	.090	5.08	.408	2.148	.102
7	6.41	.77	2.772	.084	6.32	.588	2.975	.105	5.93	.476	2.506	.119
8	7.33	.88	3.168	.096	7.22	.672	3.400	.120	6.78	.544	2.864	.136
9	8.24	.99	3.564	.108	8.13	.756	3.825	.135	7.62	.612	3.222	.153
10	9.16	1.10	3.960	.120	9.03	.840	4.250	.150	8.47	.680	3.580	.170
11	10.08	1.21	4.356	.132	9.93	.924	4.675	.165	9.32	.748	3.938	.187
12	10.99	1.32	4.752	.144	10.84	1.008	5.100	.180	10.16	.816	4.296	.204
13	11.91	1.43	5.148	.156	11.74	1.092	5.525	.195	11.01	.884	4.654	.221
14	12.82	1.54	5.544	.168	12.64	1.176	5.950	.210	11.86	.952	5.012	.238
15	13.73	1.65	5.940	.180	13.54	1.260	6.375	.225	12.70	1.020	5.370	.255
16	14.66	1.76	6.336	.192	14.45	1.344	6.800	.240	13.55	1.088	5.728	.272
17	15.57	1.87	6.732	.204	15.35	1.428	7.225	.255	14.40	1.156	6.086	.289
18	16.49	1.98	7.128	.216	16.25	1.512	7.650	.270	15.25	1.224	6.444	.306
19	17.40	2.09	7.524	.228	17.16	1.596	8.075	.285	16.09	1.292	6.802	.323
20	18.32	2.20	7.920	.240	18.06	1.680	8.500	.300	16.94	1.360	7.160	.340

LBS.	WHEAT STRAW				OAT STRAW				RYE STRAW			
1	.904	.004	.363	.004	.908	.012	.386	.008	.929	.006	.406	.004
2	1.808	.008	.726	.008	1.816	.024	.772	.016	1.858	.012	.812	.008
3	2.712	.012	1.089	.012	2.724	.036	1.158	.024	2.787	.018	1.218	.012
4	3.616	.016	1.452	.016	3.632	.048	1.544	.032	3.716	.024	1.624	.016
5	4.520	.020	1.815	.020	4.540	.060	1.930	.040	4.645	.030	2.030	.020

TABLE XIII—GIVING POUNDS OF DRY MATTER AND DIGESTIBLE NUTRIENTS CONTAINED IN A GIVEN NUMBER OF POUNDS OF FOOD STUFF (Continued)

LBS.	CORN SILAGE				SORGHUM SILAGE				CLOVER SILAGE			
	COMPOSITION				COMPOSITION				COMPOSITION			
		DIGESTIBLE				DIGESTIBLE				DIGESTIBLE		
	Dry matter	Protein	Carbo-hydrates	Fat	Dry matter	Protein	Carbo-hydrates	Fat	Dry matter	Protein	Carbo-hydrates	Fat
10	2.09	.090	1.130	.070	2.39	.060	1.490	.020	2.80	.200	1.350	.100
11	2.30	.099	1.243	.077	2.63	.066	1.639	.022	3.08	.220	1.485	.110
12	2.51	.108	1.356	.084	2.87	.072	1.788	.024	3.36	.240	1.520	.120
13	2.72	.117	1.469	.091	3.11	.078	1.937	.026	3.64	.260	1.755	.130
14	2.93	.126	1.582	.098	3.35	.084	2.086	.028	3.92	.280	1.890	.140
15	3.13	.135	1.695	.105	3.58	.090	2.235	.030	4.20	.300	2.025	.150
16	3.34	.144	1.808	.112	3.82	.096	2.384	.032	4.48	.320	2.160	.160
17	3.55	.153	1.921	.119	4.06	.102	2.533	.034	4.76	.340	2.295	.170
18	3.76	.162	2.034	.126	4.30	.108	2.682	.036	5.04	.360	2.430	.180
19	3.97	.171	2.147	.133	4.54	.114	2.831	.038	5.32	.380	2.565	.190
20	4.18	.180	2.260	.140	4.78	.120	2.980	.040	5.60	.400	2.700	.200
21	4.39	.189	2.373	.147	5.02	.126	3.129	.042	5.88	.420	2.835	.210
22	4.60	.198	2.486	.154	5.26	.132	3.278	.044	6.16	.440	2.970	.220
23	4.81	.207	2.589	.161	5.50	.138	3.427	.046	6.44	.460	3.105	.230
24	5.02	.216	2.712	.168	5.74	.144	3.576	.048	6.72	.480	3.240	.240
25	5.22	.225	2.825	.175	5.97	.150	3.725	.050	7.00	.500	3.375	.250
26	5.43	.234	2.938	.182	6.21	.156	3.874	.052	7.28	.520	3.510	.260
27	5.64	.243	3.051	.189	6.45	.162	4.023	.054	7.56	.540	3.645	.270
28	5.85	.252	3.164	.196	6.69	.168	4.172	.056	7.84	.560	3.780	.280
29	6.06	.261	3.277	.203	6.93	.174	4.321	.058	8.12	.580	3.915	.290
30	6.27	.270	3.390	.210	7.17	.180	4.470	.060	8.40	.600	4.050	.300
31	6.48	.279	3.503	.217	7.41	.186	4.619	.062	8.68	.620	4.185	.310
32	6.69	.288	3.616	.224	7.65	.192	4.768	.064	8.96	.640	4.320	.320
33	6.90	.297	3.729	.231	7.89	.198	4.917	.066	9.24	.660	4.455	.330
34	7.11	.306	3.842	.238	8.13	.204	5.066	.068	9.52	.680	4.590	.340
35	7.31	.315	3.955	.245	8.36	.210	5.215	.070	9.80	.700	4.725	.350
36	7.52	.324	4.068	.252	8.60	.216	5.364	.072	10.08	.720	4.860	.360
37	7.73	.333	4.181	.259	8.84	.222	5.513	.074	10.36	.740	4.995	.370
38	7.94	.342	4.294	.266	9.08	.228	5.662	.076	10.64	.760	5.130	.380
39	8.15	.351	4.407	.273	9.32	.234	5.811	.078	10.92	.780	5.265	.390
40	8.36	.360	4.520	.280	9.56	.240	5.960	.080	11.20	.800	5.400	.400

TABLE XIII—GIVING POUNDS OF DRY MATTER AND DIGESTIBLE NUTRIENTS CONTAINED IN A GIVEN NUMBER OF POUNDS OF FOOD STUFF (Continued)

LBS.	SUGAR BEETS				MANGELS				RUTABAGAS			
	COMPOSITION				COMPOSITION				COMPOSITION			
	Dry matter	DIGESTIBLE			Dry matter	DIGESTIBLE			Dry matter	DIGESTIBLE		
		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat
5	.675	.055	.510	.005	.455	.055	.270	.005	.570	.050	.405	.010
6	.810	.066	.612	.006	.546	.066	.324	.006	.684	.060	.486	.012
7	.945	.077	.714	.007	.637	.077	.378	.007	.798	.070	.567	.014
8	1.080	.088	.816	.008	.728	.088	.432	.008	.912	.080	.648	.016
9	1.215	.099	.918	.009	.819	.099	.486	.009	1.026	.090	.729	.018
10	1.350	.110	1.020	.010	.910	.110	.540	.010	1.140	.100	.810	.020
11	1.485	.121	1.122	.011	1.001	.121	.594	.011	1.254	.110	.891	.022
12	1.620	.132	1.224	.012	1.092	.132	.648	.012	1.368	.120	.972	.024
13	1.755	.143	1.326	.013	1.183	.143	.702	.013	1.482	.130	1.053	.026
14	1.890	.154	1.428	.014	1.274	.154	.756	.014	1.596	.140	1.134	.028
15	2.025	.165	1.530	.015	1.365	.165	.810	.015	1.710	.150	1.215	.030
16	2.160	.176	1.632	.016	1.456	.176	.864	.016	1.824	.160	1.296	.032
17	2.295	.187	1.734	.017	1.547	.187	.918	.017	1.938	.170	1.377	.034
18	2.430	.198	1.836	.018	1.638	.198	.972	.018	2.052	.180	1.458	.036
19	2.565	.209	1.938	.019	1.729	.209	1.026	.019	2.166	.190	1.539	.038
20	2.700	.220	2.040	.020	1.820	.220	1.080	.020	2.280	.200	1.620	.040

TABLE XIII—GIVING POUNDS OF DRY MATTER AND DIGESTIBLE NUTRIENTS CONTAINED IN A GIVEN NUMBER OF POUNDS OF FOOD STUFF (Continued)

LBS.	CORN FODDER				CORN STOVER				SORGHUM FODDER			
	COMPOSITION				COMPOSITION				COMPOSITION			
	Dry matter	DIGESTIBLE			Dry matter	DIGESTIBLE			Dry matter	DIGESTIBLE		
		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat
5	2.89	.125	1.730	.060	2.97	.085	1.620	.035	2.51	.120	1.605	.080
6	3.47	.150	2.076	.072	3.57	.102	1.944	.042	3.02	.144	1.926	.096
7	4.05	.175	2.422	.084	4.16	.119	2.268	.049	3.52	.168	2.247	.112
8	4.62	.200	2.768	.096	4.76	.136	2.592	.056	4.02	.192	2.568	.128
9	5.20	.225	3.114	.108	5.35	.153	2.916	.063	4.53	.216	2.889	.144
10	5.78	.250	3.460	.120	5.95	.170	3.240	.070	5.03	.240	3.210	.160
11	6.36	.275	3.806	.132	6.54	.187	3.564	.077	5.53	.264	3.531	.176
12	6.94	.300	4.152	.144	7.14	.204	3.888	.084	6.04	.288	3.852	.192
13	7.51	.325	4.498	.156	7.73	.221	4.212	.091	6.54	.312	4.173	.208
14	8.09	.350	4.844	.168	8.33	.238	4.536	.098	7.04	.336	4.494	.224
15	8.67	.375	5.190	.180	8.92	.255	4.860	.105	7.54	.360	4.815	.240
16	9.25	.400	5.536	.192	9.52	.272	5.184	.112	8.05	.384	5.136	.256
17	9.83	.425	5.882	.204	10.11	.289	5.508	.119	8.55	.408	5.457	.272
18	10.40	.450	6.228	.216	10.71	.306	5.832	.126	9.05	.432	5.778	.288
19	10.98	.475	6.574	.228	11.30	.323	6.156	.133	9.56	.456	6.099	.304
20	11.56	.500	6.920	.240	11.90	.340	6.480	.140	10.06	.480	6.420	.320

TABLE XIII—GIVING POUNDS OF DRY MATTER AND DIGESTIBLE NUTRIENTS CONTAINED IN A GIVEN NUMBER OF POUNDS OF FOOD STUFF (Continued)

LBS.	TIMOTHY				RED TOP				MILLET			
	COMPOSITION				COMPOSITION				COMPOSITION			
	Dry matter	DIGESTIBLE			Dry matter	DIGESTIBLE			Dry matter	DIGESTIBLE		
		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat
5	4.34	.140	2.170	.070	4.55	.240	2.345	.05	4.40	.160	2.425	.05
6	5.21	.168	2.604	.084	5.47	.288	2.814	.06	5.28	.192	2.910	.06
7	6.08	.196	3.038	.098	6.38	.336	3.283	.07	6.16	.224	3.395	.07
8	6.94	.224	3.472	.112	7.29	.384	3.752	.08	7.04	.256	3.880	.08
9	7.81	.252	3.906	.126	8.20	.432	4.221	.09	7.92	.288	4.365	.09
10	8.68	.280	4.340	.140	9.11	.480	4.690	.10	8.80	.320	4.850	.10
11	9.55	.308	4.774	.154	10.02	.528	5.159	.11	9.68	.352	5.335	.11
12	10.42	.336	5.208	.168	10.93	.576	5.628	.12	10.56	.384	5.820	.12
13	11.28	.364	5.642	.182	11.84	.624	6.097	.13	11.44	.416	6.305	.13
14	12.15	.392	6.076	.196	12.75	.672	6.566	.14	12.32	.448	6.790	.14
15	13.02	.420	6.510	.210	13.66	.720	7.035	.15	13.20	.480	7.275	.15
16	13.89	.448	6.904	.224	14.58	.768	7.504	.16	14.08	.512	7.760	.16
17	14.76	.476	7.378	.238	15.49	.816	7.973	.17	14.96	.544	8.245	.17
18	15.62	.504	7.812	.252	16.40	.864	8.442	.18	15.84	.576	8.730	.18
19	16.42	.532	8.246	.266	17.31	.912	8.911	.19	16.72	.608	9.215	.19
20	17.28	.560	8.680	.280	18.22	.960	9.380	.20	17.60	.640	9.700	.20

TABLE XIII—GIVING POUNDS OF DRY MATTER AND DIGESTIBLE NUTRIENTS CONTAINED IN A GIVEN NUMBER OF POUNDS OF FOOD STUFF (Continued)

LBS.	KENTUCKY BLUE GRASS (fresh)				FODDER CORN (green)				ALFALFA (fresh)			
	COMPOSITION				COMPOSITION				COMPOSITION			
	Dry matter	DIGESTIBLE			Dry matter	DIGESTIBLE			Dry matter	DIGESTIBLE		
		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat		Protein	Carbo-hydrates	Fat
10	3.490	.300	1.980	.080	2.070	.100	1.160	.040	2.820	.390	1.270	.050
11	3.839	.330	2.178	.088	2.277	.110	1.276	.044	3.102	.429	1.397	.055
12	4.188	.360	2.376	.096	2.484	.120	1.396	.048	3.384	.468	1.524	.060
13	4.537	.390	2.574	.104	2.691	.130	1.508	.052	3.666	.507	1.651	.065
14	4.886	.420	2.772	.112	2.898	.140	1.624	.056	3.948	.546	1.778	.070
15	5.235	.450	2.970	.120	3.105	.150	1.740	.060	4.230	.585	1.905	.075
16	5.584	.480	3.168	.128	3.312	.160	1.856	.064	4.512	.624	2.032	.080
17	5.933	.510	3.366	.136	3.519	.170	1.972	.068	4.794	.663	2.159	.085
18	6.282	.540	3.564	.144	3.726	.180	2.088	.072	5.076	.702	2.286	.090
19	6.631	.570	3.762	.152	3.933	.190	2.204	.076	5.358	.741	2.413	.095
20	6.980	.600	3.960	.160	4.140	.200	2.320	.080	5.640	.780	2.540	.100
21	7.329	.630	4.158	.168	4.347	.210	2.436	.084	5.922	.819	2.667	.105
22	7.678	.660	4.356	.176	4.554	.220	2.552	.088	6.204	.858	2.794	.110
23	8.027	.690	4.554	.184	4.761	.230	2.668	.092	6.486	.897	2.921	.115
24	8.376	.720	4.752	.192	4.968	.240	2.784	.096	6.768	.936	3.048	.120
25	8.725	.750	4.950	.200	5.185	.250	2.900	.100	7.056	.975	3.175	.125

PURDUE UNIVERSITY
Agricultural Experiment Station

Circular No. 27

LaFayette, Ind., April, 1911

SUGGESTIONS FOR BEGINNERS IN ALFALFA CULTURE

A. T. Wiancko, Chief in Soils and Crops

INTRODUCTION

There is now no longer any doubt concerning the adaptation of alfalfa to Indiana conditions. Its high feeding value and its ability to produce large yields are established facts. Many farmers in various parts of the state are successfully producing large areas of it. In every neighborhood the interest in its production is becoming more and more marked and the time is not far distant when this valuable forage crop will play an important part in Indiana agriculture.

As with all crops that are new to the farmer or to the local conditions, there is much to be learned about alfalfa before it can be successfully produced. The nature of the plant must be carefully considered and its habits of growth, its needs in the way of plant food, the soils best suited to it, and its cultural requirements must be understood. Without such knowledge much disappointment is likely to result, and no one should attempt to raise alfalfa without first making a thorough study of the subject.

Recognizing the value of the crop and its possibilities for better agriculture, this Station began experiments with it a number of years ago with the purpose of finding out its cultural requirements. In recent years these experiments have been conducted in

large numbers throughout the state, on all the principal soil types and in practically every county. As a result of these investigations, there has been collected a large amount of valuable information concerning the requirements of alfalfa, its behavior under different surroundings, and the best methods of dealing with it.

This circular is prepared with a view to answering the more important of the many questions that come to the Station from farmers desiring to try this crop.

SOILS FOR ALFALFA

Many people make the fatal mistake of expecting alfalfa to do well on soils that are not fit to properly produce any kind of a crop. There is just as much need of care in selecting and preparing soils for alfalfa as for any other crop and probably more, because of its deep rooting habits and large plant food requirements.

Deep, loamy soils with open subsoils are undoubtedly best for alfalfa, but there is plenty of evidence to show that it may be successfully produced on almost any type of soil, from light sandy or gravelly loams and mucks to heavy clays, providing that they are well drained, sweet and properly supplied with available plant food. In 348 trials conducted by this Station during the last five years, 68 out of 83 clays, 167 out of 188 loams, and 69 out of 77 sandy soils gave satisfactory results. Failures seemed to be due to factors other than the types of soil.

Many soils that at present are not fit for alfalfa culture may be made so by providing drainage facilities, correcting acidity, adding organic matter, or supplying needed plant food, according to the requirements. Good drainage is essential in order that the roots may go deep into the soil. Hardpan must be broken up or avoided altogether. Soils that are sour may be made sweet by thorough drainage and the application of lime. A good supply of decomposable organic matter in the soil helps the bacterial action in making plant food available, facilitates the inoculating process, and together with good drainage prevents heaving in the spring.

Muck soils may be used for alfalfa if they are well drained and properly supplied with mineral plant food. Potash is nearly always lacking in these soils and often phosphoric acid and lime must also be supplied. Soils that are subject to flooding are not good for alfalfa.

SOIL FERTILIZATION

Alfalfa requires large quantities of plant food and cannot be expected to do well on poor soils. Its deep rooting habits may enable it to extract more food from the soil than most other crops, but

to secure large yields there must be an abundance of food within easy reach and if the soil is not naturally well supplied, manure or commercial fertilizer must be added. After it is thoroughly established and properly inoculated with its nitrogen gathering bacteria, alfalfa will supply itself with nitrogen from the air, but all potash, phosphoric acid, and other mineral food must come from the soil and as the crop is naturally a large producer, large quantities are required. Of the plant food that must come from the soil, potash and phosphoric acid are most largely required and these are the two substances in which the soil is most likely to be deficient. Every ton of alfalfa hay which is removed from the land takes with it about 11 pounds of phosphoric acid and 49 pounds of potash.

Every alfalfa field should be started with a liberal dressing of stable manure, if possible. Experiments have proven time and again that manure is unusually valuable in starting alfalfa. It not only supplies plant food but improves the physical condition of the soil and facilitates the inoculating process. In many of the experiments conducted by this Station, special inoculation of the soil was found unnecessary when plenty of manure was applied.

When sufficient manure is not available and the soil is not already rich, a high grade commercial fertilizer should be used. Just what will be required will depend upon the character and condition of the soil. In most instances, however, it will be well to use a fertilizer rich in both phosphoric acid and potash. A mixture containing a little nitrogen, perhaps 2 per cent., and 8 to 10 per cent. of phosphoric acid and the same of potash, applied at the rate of three or four hundred pounds per acre will be sufficient unless the soil is quite poor, in which case heavier applications may be profitable. The fertilizer should be disked into the ground some time in advance of seeding.

LIMING SOILS FOR ALFALFA

To what extent Indiana soils are in need of liming in order to successfully produce alfalfa is not definitely known. It is known, however, that alfalfa will not thrive in soils that are sour and that there are many such in the state. In some of the experiments conducted during the last few years, liming has been found to increase the yields of alfalfa, while in other cases the lime produced no apparent effect.

Soils that produce good crops of clover will probably not be seriously in need of liming for alfalfa. On the other hand, where there is trouble in getting a stand of clover, or where this crop does not otherwise succeed well, it will usually pay to lime the soil, and liming may be actually necessary before alfalfa will do well, because the alfalfa bacteria will not thrive in acid soils.

In the case of soils that are sour because of lack of drainage, liming alone will not be sufficient. Drainage must receive first attention. The soil must also be otherwise put into good physical condition by proper tillage methods, the addition of humus, etc. After these things have been attended to, if the soil is in need of lime this substance can do its work properly.

The most satisfactory method of determining whether or not a soil is in need of liming, is to make a small trial application of lime on a patch sown with alfalfa, some time before seeding the whole field. Such an experiment may result in saving the expense of liming and is well worth making, where there is serious doubt, because in many instances there is a sufficient natural supply of lime in the soil. In some portions of the state where there is an abundance of limestone, the soils may, nevertheless, respond to applications of lime because they bear no direct relation to the rock upon which they rest.

Where liming is necessary, an application of ground limestone will usually be most economical, although other forms of lime will give equally good results. The amount that should be applied will depend upon the needs of the soil, but probably not less than two tons of ground limestone per acre should be used, and double this amount may be profitable. It may be applied at any time but the longer before sowing the alfalfa the better. It is a good plan to begin preparing the ground for alfalfa a year or so in advance and in that case the lime may be applied when preparing the soil for the preceding crop. If the ground for alfalfa is to be plowed in the fall, the lime may be applied at that time. In spring preparation, the lime should be applied immediately after plowing and disked into the soil so as to give it as much time to act as possible before seeding.

THE TIME TO GROW ALFALFA

If the weather conditions are favorable and the soil is in good condition and free of weed seeds, it does not seem to make any important difference when the seed is sown so long as there is sufficient time for the young plants to thoroughly establish themselves before winter, and good results may be secured at any time from April to August. Trouble with weeds is most likely to arise with the earlier seeding, while with the later seeding there is liable to be an insufficient supply of moisture in the soil to permit of proper soil preparation, and the germination of the seed and the development of the plants may be seriously delayed by periods of drought. In the Experiment Station's trials with late summer seeding during the last five years, periods of drought have been occasionally encountered in different parts of the state, which have more

or less seriously interfered with getting a satisfactory stand or a sufficient amount of growth before winter. To insure success, it therefore, seems wisest to sow somewhat earlier. Seedings made in April or May, on the other hand, are so liable to be troubled with weeds that such early seeding is not advisable, even with the use of a nurse crop, unless the ground is known to be free of weed seeds. On this point we would especially caution farmers, as few realize how full of weed seeds the soil really is. *Trouble with weeds has caused more alfalfa failures than any other one thing.*

On account of the danger of trouble with weeds in spring seeding and the liability of interference by drought in late summer seeding, it is undoubtedly safest and best, where it can be done, to spend the spring in ridding the ground of weed seeds and then sow the alfalfa alone about the end of June or early in July. In this case the ground should be plowed in the spring, turning under some manure if possible and then harrowed every 10 days or two weeks until seeding time. Each successive harrowing will kill the weeds that have started and put a fresh lot of seeds in position to germinate until, finally, all weed seeds near enough to the surface to grow will be sprouted and killed.

When spring seeding is to be practiced, a light seeding of oats or beardless barley, about a bushel and a half per acre, may be used as a nurse crop. This nurse crop should usually be cut for hay soon after heading and removed from the field. With summer seeding a nurse crop should not be used.

PREPARING THE SEED-BED AND KILLING WEEDS

Preparation of the soil for alfalfa should usually be begun with the preceding crop, applying any needed lime at that time. What the preceding crop is does not seem to be important so long as it will permit of thorough soil preparation for the alfalfa. A corn crop which can be given clean culture will usually be best, though for summer seeding any spring sown crop which can be removed early in the summer may be used. Early potatoes, peas for canning, clover and small grain crops can all be used to precede summer sowing. In any case, a fine, mellow seed-bed with a firm sub-surface should be prepared and weed seeds killed by repeated harrowing, as directed in preceding paragraphs. Extra deep plowing is not advisable. Where alfalfa is to follow peas or early potatoes, a good seed-bed can usually be prepared without plowing.

METHOD AND RATE OF SEEDING

Probably the best method of sowing alfalfa seed is with a drill, as by this means it may be covered most uniformly. When

a nurse crop is sown with it, as in the case of spring seeding, the alfalfa seed should be put into the grass seed attachment and dropped ahead of the drill shoes. In the case of summer seeding, without a nurse crop, drilling the same as wheat, with the drill set to run as shallow as possible, will usually be best. If the drill cannot be adjusted to sow small amounts, enough coarse corn meal may be mixed with the alfalfa seed to increase the quantity so that the drill will handle it properly. When drilling is not convenient, the seed may be sown broadcast and lightly covered with a harrow.

The rate of seeding should be about 20 pounds per acre.

INOCULATION

To get the most out of the alfalfa crop and, in fact, before it can make its best development, the roots must be inoculated with the proper nodule forming, nitrogen gathering bacteria. In the majority of cases where alfalfa is sown for the first time, it will need to be inoculated by some artificial means. The surest and most practical way to do this is to broadcast and harrow in, before sowing the seed, some earth from a good alfalfa field where the bacteria are known to exist. At least two or three hundred pounds of soil per acre should be used. In securing this soil, care should be taken to secure it from a clean, healthy field so as to avoid the introduction of weed seeds or plant diseases. Care must be exercised, also, to guard against exposing the soil for inoculation to sunlight for too long a time before sowing and harrowing it in as such exposure is detrimental to the bacteria. Inoculation may also be effected by mixing and drilling in with the alfalfa seed a small quantity of soil rich in bacteria, but the success of this method is not fully established. The use of pure cultures of alfalfa bacteria has not been generally satisfactory, and probably because, with present methods, the bacteria are either dead before they reach the farmer or he is not sufficiently careful in their application. Some farmers are successfully inoculating their soil for alfalfa by sowing some alfalfa seed with clover a year or two before sowing alfalfa alone.

CLIPPING YOUNG ALFALFA

The information we have concerning the clipping of alfalfa during the first season is too contradictory to permit of formulating any general rule. It seems, however, that clipping has sometimes been overdone and that young alfalfa should rather be allowed to grow undisturbed so long as it is doing well and does not bloom. In the case of early seeding, one clipping late in the summer will usually be sufficient. Generally speaking, clipping should be prac-

ticed only when the growth seems checked, or the tops of the plants turn yellow. If not too heavy, the cut material should be left on the ground to act as a mulch. In the case of summer seeding, all growth should be allowed to die down naturally for protection over winter.

CUTTING FOR HAY

When alfalfa is used for hay it should be cut whenever the new shoots at the crowns of the plants are well started. This is a better guide as to the proper time of cutting than the appearance of blossoms. Whenever the tops turn yellow, or the leaves become seriously affected by 'leaf-spot" it should also be cut, even though the fresh shoots have not started.

PASTURING

Alfalfa should never be pastured the first season, and in most cases it will be best to use it for hay-making during the second season, in order that it may become thoroughly established before animals are allowed to tramp over it. It should never be pastured closely, as this injures the crowns of the plants. Horses and sheep are more likely to do damage in this way than are cattle or hogs. With cattle and sheep, care must be exercised to avoid bloating. At first the animals should be turned in for only a short time each day, and when the alfalfa is wet with dew or rain there is still greater need of care to avoid bloating. It is wise to be a little more careful than with clover.

SUMMARY

Alfalfa may be successfully raised on almost any type of soil providing that it is well drained, free of weeds and in a reasonable state of fertility.

Good drainage must be provided.

The ground must be made free of weed seeds.

Soils lacking in fertility should be well manured, as alfalfa requires large amounts of plant food. If sufficient manure is not to be had, it should be supplemented with a commercial fertilizer rich in phosphoric acid and potash.

If the soil is sour, it must be limed before alfalfa can do well.

Inoculation of the soil will generally be necessary.

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 28

LaFayette, Ind., July, 1911

AGRICULTURAL EXTENSION
XI

WHAT PURDUE IS DOING FOR INDIANA AGRICULTURE

Purdue University is headquarters for the greatest industry of Indiana, namely, Agriculture. Located and maintained at Purdue as a part of the University are the following institutions:

The Agricultural Experiment Station
The School of Agriculture
The Department of Agricultural Extension

Located also at Purdue are the offices of the Secretaries of

The State Corn Growers' Association
The State Live Stock Breeders' Association
The State Horticultural Society
The State Dairy Association

Through these several branches, Purdue University bears a definite and intimate relation to the agriculture of the state.

Scientific research and experiments are conducted along the lines of soils, crops, animal husbandry, dairying, horticulture, veterinary, poultry, botany and entomology, in an attempt to solve the problems of the farmers of the state.

Courses of instruction in the various phases of agriculture are given to persons who attend the University.

Information relating to results of experiments, teachings of the School of Agriculture and agriculture in general, is projected into the state by means of special educational trains, short courses, lectures, demonstrations, cooperative experiments, bulletins, circulars, correspondence, etc.

The main object of all this work is to improve agricultural conditions and to retain a prosperous and happy people on Indiana farms.

Information on work of the several departments will be found on following pages. Read carefully.

Purdue, Progress, Prosperity

AGRICULTURAL EXPERIMENT STATION PUBLICATIONS[1]

Bulletin No. 136, October, 1909. Steer Feeding, IV; Winter Steer Feeding, 1908-9.

Bulletin No. 137, November, 1909. Dairy By-Products as Supplements to Corn for Fattening Hogs.

Bulletin No. 138, February, 1910. The San Jose Scale: some Sprays for its Control.

Bulletin No. 139, February, 1910. Results of Cooperative Tests of Varieties of Corn, Wheat, Oats, Soy Beans and Cow Peas, 1909.

Bulletin No. 140, February, 1910. Hog Cholera.

Bulletin No. 142, May, 1910. Steer Feeding, V; Finishing Steers, 1907, 1908 and 1909.

Bulletin No. 143, May, 1910. (popular edition) Standards for Evaporated Milk, Sweetened Condensed Milk, and Condensed Skimmilk. Federal and State Dairy Laws.

Bulletin No. 144, May, 1910. Growing Tomatoes for the Canning Factory.

Bulletin No. 145, October, 1910. (popular edition) Testing Cream for Butter Fat.

Bulletin No. 146, June, 1910. Steer Feeding, VI: Influence of Age on the Economy and Profit from Feeding Calves, Yearlings, and Two-year-olds, 1906-7; 1907-8, 1908-9.

Bulletin No. 147, June, 1910. Corn Silage for Winter Feeding of Ewes and Young Lambs.

Bulletin No. 149, March, 1911. Summary of Five Years' Results of Cooperative Tests of Varieties of Corn, Wheat, Oats, Soy Beans and Cow Peas, 1906-1910.

Circular No. 17, September, 1909. The Farmers' Orchard.

Circular No. 18, November, 1909. Corn Shows and Selecting, Preparing and Scoring Exhibits.

Circular No. 19, November, 1909. Industrial Contests for Boys and Girls.

Circular No. 20, December, 1909. Milk Production, III; Economic and Sanitary Milk Production.

Circular No. 21, February, 1910. Spraying the Orchard.

Circular No. 22, March, 1910. The Loose Smut of Oats and Stinking Smut of Wheat and their Prevention.

Circular No. 23, July, 1910. How to Grow More and Better Wheat.

Circular No. 25, March, 1911. How to Grow More and Better Corn.

Circular No. 26, April, 1911. Computing Rations for Dairy Cows.

Circular No. 27, April, 1911. Suggestions for Beginners in Alfalfa Culture.

[1]Complete list of available publications can be had upon application

AGRICULTURAL EXPERIMENT STATION

ARTHUR GOSS, Director

The Agricultural Experiment Station is an institution founded in 1887 by an Act of Congress known as the "Hatch Act." It is supported partly by federal and partly by state appropriations. The Station is maintained for the purpose of acquiring and disseminating agricultural knowledge. This is accomplished by conducting experiments and research work and distributing the knowledge gained through such investigations, by means of publications, correspondence, lectures, demonstrations, special trains, exhibits, and in various other ways. During the year just closed, besides answering many thousands of letters, the Station issued over 31,000,000 pages of printed matter. The bulletins and circulars of the Station are sent free to such persons interested in agriculture as request the same.

The work of the Station is carried on by a staff of about 50 people, who are all experts in their various fields.

The Station is divided into nine departments as follows:

1. The General or Administrative Department, of which the Director is the head, whose function it is to exercise general supervision of the affairs of the Station and to look after the finances.

2. The Animal Husbandry Department, whose function it is to handle matters relating to the animal industry of the state, such as the growing and feeding of the different kinds of live stock. This department also embraces the Division of Poultry Husbandry.

3. The Botanical Department, which deals with matters relating to the control of plant diseases and weed pests.

4. The Dairy Department, which concerns itself with matters relating to the dairy interests of the state.

5. The Department of Horticulture and Entomology, which looks after the fruit industry and insect pests.

6. The State Chemist Department, which is concerned with the administration of the state feeding stuff and fertilizer laws.

7. The Soils and Crops Department, which conducts investigations and furnishes information in regard to the improvement of the soils and crops of the state.

8. The Veterinary Department, which deals with hog cholera and other animal diseases.

9. The Extension Department, whose function it is to project the work of the different scientific departments in such a way that it may be of the most use to the people of the state.

It is believed that the work of the Station is of the highest value to the farmers of the state; that the appreciation of the same is rapidly increasing, there can be no doubt. Only a few years since, one of the chief difficulties was to arouse interest among the farmers in the work of the Station and induce them to take advantage of the information at command. Today, one of the most difficult problems is to satisfy the urgent demand that is coming from our farmers for aid and information along agricultural lines.

ANIMAL HUSBANDRY DEPARTMENT

J. H. Skinner, Chief in Animal Husbandry
F. G. King, Associate in Animal Husbandry
A. G. Philips, Associate in Poultry Husbandry
D. O. Thompson, Animal Husbandry Extension

The aim of the Animal Husbandry Department has been to study practical live stock problems confronting Indiana farmers and answer questions of vital importance to the success of those who are handling beef cattle, hogs and sheep.

Broadly speaking, the work of the Department is of two distinct classes:

1. Experimental investigation
2. Extension

EXPERIMENTAL INVESTIGATION

Cattle Feeding.—By exhaustive experiments covering a period of six years and involving more than 40 lots of cattle, the Department has demonstrated many important facts.

The following definite conclusions can be drawn:

1. Clover hay is far superior to timothy hay or oat straw for fattening cattle. Bulletin No. 115.

2. Corn silage will decrease the cost of making gains on fattening cattle 50 cents to $2.00 per 100 pounds. Bulletins Nos. 129, 136 and 153.

3. The addition of cottonseed meal to a ration of corn and clover hay in dry lot will increase the selling price of the cattle, increase the rate of gain and not increase the cost of gains. Bulletins Nos. 129, 136 and 142.

4. It is necessary to feed cottonseed meal or some other highly nitrogenous concentrate with corn in order to secure the best results from corn silage. Bulletins Nos. 129 and 136.

5. The cost of making gains is greater with old cattle than with young, but the time required to finish for market is much less. Bulletins Nos. 129, 136 and 146.

6. The effect of long vs. short feeding is too greatly affected by the size and quality of cattle and the demands of the market to warrant any conclusions. Bulletin No. 130.

Problems now being studied:

1. The proper amount of silage to use in a fattening ration.

2. The proper amount of cottonseed meal to use in a ration both with and without silage.

3. Value of silage and hay without grain the first part of the fattening period.

4. The effect of using silage alone as roughage for fattening cattle. Publications on these subjects are now in press.



Fig. 1

Type of steer that makes rapid gains. Straight back, deep body, round ribs and mild temperament. Gain 3.31 lbs. daily



Fig. 2

Type of steer that makes poor gains. Shallow, angular body, flat ribs and wild disposition. Gain 1.83 lbs. daily

Pork Production.—Within the last 16 years the Department has made a conclusive study of the advisability and economy of adding to corn, fed fattening hogs in dry lot, such feeds as tankage, skim milk, buttermilk, linseed oilmeal, soy beans, middlings, etc. The complete results of these studies have been reported in bulletin form as follows:

Bulletin No. 108.—Soy Beans, Middlings, and Tankage as Supplements in Pork Production.

Bulletin No. 126.—Supplements to Corn for Fattening Hogs in Dry Lot. (This consists of comparisons between tankage, linseed oilmeal, and soy beans as supplements to corn).

Bulletin No. 137.—Dairy By-products as Supplements to Corn for Fattening Hogs. (This consists of comparisons between skim milk, rape, linseed oilmeal, tankage, soy bean meal, middlings, and buttermilk as supplements to corn for dry lot hog feeding).

In addition to the above published results, data has also been secured on the different proportions of water for growing hogs, the value of different forage crops for hogs, maintenance of brood sows, and the value of hominy feed as a substitute for corn for fattening hogs.

Mutton Production.—The first systematic lamb feeding trial was conducted in the winter of 1910-11 with seven lots of western lambs weighing 56 pounds. The object was to determine:

1. The relative value of clover and timothy hay for fattening lambs.
2. The value of silage for lamb feeding.
3. The proper amount of silage to feed to fattening lambs.
4. The effect of adding cottonseed meal to a ration of corn and timothy hay; corn and clover hay; and corn, silage and clover hay.



Fig. 3. Experimental sheep feeding shed and lots. Shed 112 feet long and 22 feet deep divided into eight lots opening to the south. Each lot has 224 square feet of shed and 392 square feet of open yard. All feed is fed in racks under shed



Fig. 4

A view of a part of the experimental cattle lots



Fig. 5

Lambs fed on corn, cottonseed meal, clover hay, and corn silage. Daily gain .339 pounds. Cost per cwt. gain $4.66

The data is yet unpublished, but has shown the inadvisability of using timothy hay and also that silage can very profitably be used for lamb feeding.

A study has also been made of "hot house" lamb production and of the value of corn silage and other roughages for wintering breeding ewes, the results of which are published in Bulletin No. 147.—Corn Silage for Winter Feeding of Ewes and Young Lambs.

EXTENSION

The information obtained by the experiments which have been conducted by this department is of little value to the farmers of the state unless it is put before them in a direct, workable form. Getting the results of the work out to the farmers in such form that they will be of value is an important phase of the work of this department.

The work along this line for some years has consisted of:

1. Addresses before farmers' institutes, meetings of feeders and breeders, etc.

2. Lectures and stock judging demonstrations at the district short courses held in the state.

3. Replies to inquiries received by mail from farmers and stockmen.

4. Showing visitors to the Station, the equipment and working methods of the Department.

5. Cooperating with cattle feeders in demonstration feeding trials, and in meetings at the University.

Correspondence.—Many inquiries relating to the feeding, breeding, and management of live stock and the relative feeding value of various feeding stuffs are received. Such correspondence is invited and receives prompt attention. Address, Animal Husbandry Department, Purdue Experiment Station, Lafayette, Indiana.

Visitors.—During the year many men with special problems in feeding or management take a day or two to visit the Department and see how the experimental work is carried on, and to receive at first hand such assistance in the solution of their problems as they are able to secure from the results obtained at the Station. Such visits are always welcomed, and inspection of everything connected with the work of the Department invited. Farmers having special problems are urged to bring them personally to the Department. The benefit to be derived is mutual.

Cooperative Work.—The Department has been cooperating with progressive cattle feeders who are in a position to keep rec-

ords of feed consumed, gains made, etc. The object of this cooperation is two fold: to demonstrate in a community what has been found to be true at the Station, and test these truths under the conditions of the feeders of the state; to give the men who are engaged in conducting the experimental feeding work at the Station an opportunity to become intimately acquainted with the feeders of the state and with the conditions and problems which confront them. The Station men organize these cooperative experiments or demonstrations upon request of the feeder desiring same, and visit the farm monthly to weigh and note the condition of the cattle, record the amounts of feed consumed and the cost, and calculate the cost per pound gain. When desired by the feeder,



Fig. 6. Cattle feeders inspecting experimental cattle, April 21, 1911

they also make suggestions as to feeding and management of the stock in the feed lot.

The Department cooperates twice annually with the Indiana Cattle Feeders' Association in arranging for a fall and spring meeting at the University, the fall meeting being held at the time the experimental cattle are put on feed, and the spring meeting at the conclusion of the feeding experiment. At the former meeting the plan of the experiment is outlined and at the latter, the results obtained and conclusions drawn from the feeding trial are discussed. Every interested feeder is welcomed to these meetings.

POULTRY

Poultry experimental work was begun November 1, 1910, with 100 White Leghorn pullets. The poultry farm consists of 17 acres, a third of which is fenced and used by the chickens. The central poultry building that is used for incubation, feeding, killing, storing, work shop and laboratories, is 30x50 feet, two stories high, with a well constructed basement.

The poultry houses are three in number, each 10x24 feet, divided into two pens. They are placed in yards 150x260 feet that have been newly planted with fruit trees.

EXPERIMENTAL FEEDING.—The object of this experiment is to find the feeding value of skim milk as a concentrated nitrogenous food, by using two forms of skim milk, compared with a meat food called beef scrap, and no meat food.

Method.—The 100 pullets are divided into four lots of 25 each, and fed the same grain and dry mash ration. Pen No. 1 receives in addition some skim milk; No. 2, skim milk curd; No. 3, beef scrap; No. 4, nothing. Each hen is trap nested and records of cost of feed, number of eggs and amount of manure produced, are all accurately kept.



Fig. 8. Purdue poultry building



Fig. 9. The poultry farm



Fig. 10. Colony houses of different types

INCUBATION.—Records were kept through 14 hatches, of the temperatures registered by thermometers placed in four different levels with respect to the top of the eggs. This was done in order to find the best temperature at which to run an incubator.

BROODING.—Seven different styles of colony brooder houses have been constructed and put into use in order to find the most practical brooder for the farmer or large poultryman.

Since last fall, the egg buyers of Indiana have been urged to discontinue buying eggs "case count", the present bad system, and to pay for eggs according to quality, by buying eggs "loss off". To encourage this method, four newspaper bulletins on the subjects of "Indiana Eggs Are Bad," No. 174; "How To Detect Bad Eggs," No. 175; "How To Produce Good Market Eggs," No. 176, and "How To Improve Indiana Egg Conditions," No. 177, have been distributed broadcast through the state, and made public through newspapers, with a hope of educating people to realize the present deplorable market egg conditions and to help improve them.

EXTENSION.—The extension work in poultry has consisted of addresses and demonstrations before farmers' short courses, farmers' institutes, local poultry associations, and Y. M. C. A. educational classes. The correspondence has been very heavy considering the length of time the Department has been established.

COOPERATIVE WORK.—Last fall blanks were sent out to a large number of farmers, asking questions concerning their poultry conditions, and as a result about 500 replies were obtained. This data will be compiled into a report of Indiana poultry conditions as soon as possible. About 50 farmers are keeping monthly records of expense and income from their poultry, with the idea of giving to the Department as much data as can be obtained concerning profit in farm poultry.

BOTANICAL DEPARTMENT

J. C. Arthur, Chief in Botany
F. D. Kern, Associate Botanist
F. J. Pipal, Assistant Botanist
C. R. Orton, Assistant Botanist
Evelyn Allison, Assistant in Botany
Mary A. Fitch, Assistant in Botany
Thomas Billings, Assistant in Plant Culture

The progress of agriculture and agricultural conditions in many regions are often greatly accelerated by the application of the various phases of botanical knowledge, and research.

PLANT DISEASES

Plant diseases, often causing immense agricultural losses, are largely due to minute organisms, called fungi. These often require very careful study and investigation to be thoroughly understood. When once so understood, and preventive treatments discovered,

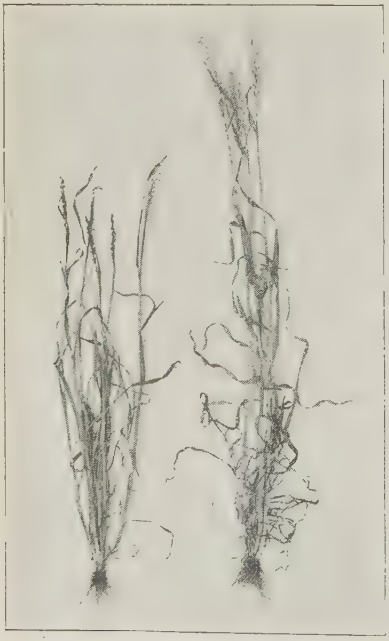


Fig. 11. Individual oat plant destroyed by oat smut contrasted with a healthy plant



Fig. 12. Field dodder. A pest in clover and alfalfa fields

it often becomes a simple matter to control such diseases and check great losses.

The treatment of seed potatoes by soaking at least two hours in a solution of one pound of formalin to 30 gallons of water before planting to prevent scab in the resulting crop was first discovered at the Purdue Experiment Station, and this has proved of great value in combating this disease.

The same chemical has also been found effective for preventing oat smut and stinking smut of wheat, and now leads all other methods for this purpose. (See Circular No. 22 for details) Other plant diseases are being investigated extensively by the Botanical Department of the Station.

WEEDS

The control of weeds on Indiana farms is assuming greater and greater importance as the value of land increases. This important work, the Botanical Department is taking up in a strong way; testing out the methods of weed control by chemical sprays as well as by short rotations and other methods. Emphasis is always placed on the great importance of avoiding further weed

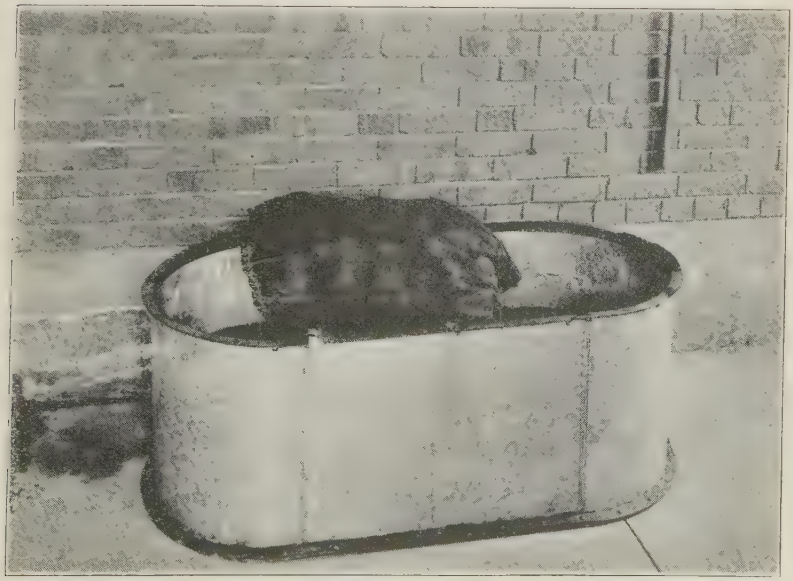


Fig. 13. Treating potatoes to prevent scab. Soak two hours, before cutting, in solution of one pound of formalin to 30 gallons of water

introduction through impure seed, through the careless use of weed infested manure applied as fertilizer, or in flood water, if that can be avoided, and especially is it important as far as possible to prevent the weeds from maturing seeds in the fields, fence rows, barn yards and waste places generally. Special efforts in the very careful cultivation of hoed crops and cleaning up generally is always well worth while. Kill the weeds while small. Prevent their going to seed. "One year's seeding is nine years' weeding!"

MUSHROOM WORK

Among other things Indiana offers opportunities for the successful growing of mushrooms. The Botanical Department has also taken up this subject, and is conducting certain experiments with the idea of improving present methods of growing this excellent vegetable.

Other problems come up from time to time and attention is always given them according to the best judgment of the officers in charge and financial support available.

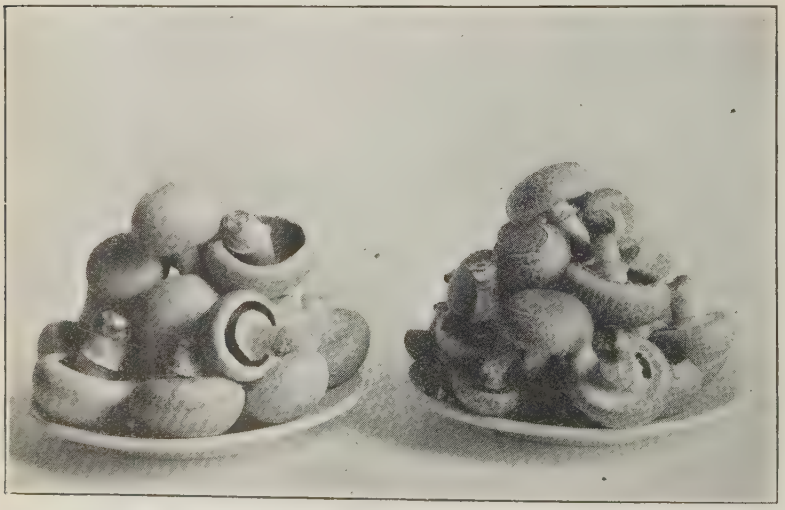


Fig. 14. Appetizing mushrooms ready for the kitchen

DEPARTMENT OF DAIRY HUSBANDRY

O.F. Hunziker, Chief in Dairy Husbandry
J. D. Jarvis, Dairy Manufactures
P. L. Roberts, Dairy Manufactures
George Spitzer, Dairy Chemistry
W. F. Epple, Dairy Chemistry
H. C. Mills, Dairy Field Work
P. H. Crane, Milk Production
W. R. Wright, Dairy Bacteriology

PURPOSE

The purpose of the Dairy Department is to furnish to the general farmer who keeps a few cows for dairy purposes as well as to the breeders of pure bred dairy cows, information that will assist in the care, selection and breeding of dairy cattle, and that will assist in the economic production of a sanitary product; to the manufacturer of butter, cheese, ice cream and condensed milk, information that will assist in the manufacturing of a legal, wholesome and economical product.



Fig. 15. A method of caring for young calves being fed by hand. They are kept in stanchions until grain is fed and their mouths have dried off so that they are not inclined to suck each other's ears

DIVISION OF WORK

The work of this department is divided into:—

1. Field work
2. Extension work
3. Experimental work

Field Work

Visits to Dairy Farms and Creameries. These visits make it possible for the dairyman and factoryman to receive personal advice and assistance for the solution of their local problems. In communities contemplating the establishment of cooperative creameries, the advisability of the installment of such creameries is carefully investigated and specifications for suitable buildings and equipment are furnished by the Department.

Butter makers receive assistance in the operation of their plants in making the proper overrun and in the manufacture of a high quality of butter, which conforms in composition with the laws of the United States Internal Revenue Department.

Calibration of Babcock Testing Glassware is done to accommodate the creameries, ice cream factories, dairymen and other firms or individuals that buy or sell milk and cream on a butter fat basis. Careful investigation has shown the necessity of having such glassware checked up by the Experiment Station to insure accuracy in the fat determination of such products.

EXTENSION WORK

Special Dairy Meetings, Institutes, District Short Courses, Special Dairy Trains, and Publications. Instruction is given to the dairy farmer on the selection and breeding of dairy cows; grading up, feeding, care and management of the dairy herd; organization of cooperative breeding associations; care and handling of milk and cream, care and operation of the farm separator and the Babcock test; farm butter making, organization of cooperative creameries; and establishment of markets for dairy products.

Send for Circular No. 11 on "The Improvement of the Dairy Herd", Circular No. 20 on "Economic and Sanitary Milk Production" and Circular No. 26, "Computing Rations for Dairy Cows".



Fig. 16. Gorgeous Boy, a typical Jersey bull, who is in the Register of Merit with three tested daughters



Fig. 17. Holstein, Jersey and Ayrshire cows that are registered in Advanced Registry or Register of Merit of their respective breed associations

Official Cow Tests are made by representatives of the Department for any Indiana breeder of pure bred dairy stock who desires to have his animals try for entry in Advanced Registry or Register of Merit as the case may be. Write for particulars regarding requirements, cost, etc.

Moisture Control of Butter. Experiments have been in operation since 1907 and sufficient data has been collected to warrant important and positive conclusions that will soon be published.



Fig. 18. Laboratory where experimental work was done determining the causes of variation in the per cent. of fat in cream

This work has been taken up from various standpoints and the most recent work has been in determining the influence of feeds upon the character of butter fat produced which in turn influences the body and moisture content of the butter. The results of this work will be of great value to the buttermaker in improving the quality and uniformity of his product.

Related Cream Separation Experiments. Experimental work was done to determine the causes of variation in the richness of cream. It embraced the consideration of such factors as:—

Richness of milk
Temperature of milk

Speed of machine
Position of cream screw
Rate of inflow

Owing to a lack of understanding of the influence of the above factors upon the richness of the cream, much dissatisfaction has arisen among producers who sell cream on a butter fat basis. A

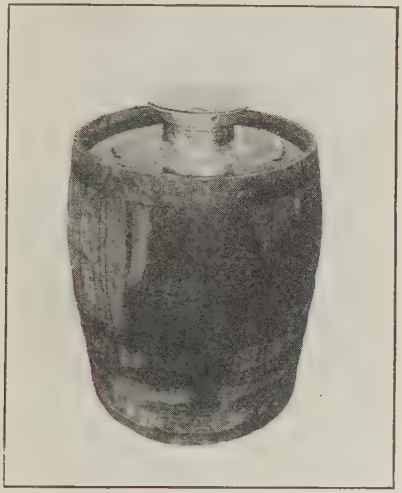


Fig. 19. A cheap and efficient method of holding milk and cream at a low temperature

better understanding of the causes of the variation in the per cent. of fat in cream and the causes of the variation of the cream test, along with an understanding of the relation of butter fat to butter, will bring about a stronger feeling of confidence between producer and dealer. These topics are treated in Bulletin No. 150.

HORTICULTURAL DEPARTMENT

James Troop, Chief in Horticulture
C. G. Woodbury, Associate Horticulturist
J. W. Wellington, Assistant Horticulturist
M. W. Richards, Assistant Horticulturist
J. G. Boyle, Assistant Horticulturist

It is the aim and the purpose of the Horticultural Department to render the greatest service to the fruit growing and vegetable growing interests of the state which it is possible to render with the resources at the Department's disposal.

The assistance given to the horticultural interests of the state takes various forms and is accomplished in a number of ways. One of the principal methods is the preparing of publications embodying the results of special investigations which have a direct bearing on the successful production of one or another horticultural crop. The following publications dealing with horticultural subjects are now available for free distribution:

Circular No. 9. Commercial Fruit Growing
Circular No. 15. Growing Onions from Seed
Circular No. 17. The Farmer's Orchard
Circular No. 21. Spraying the Orchard

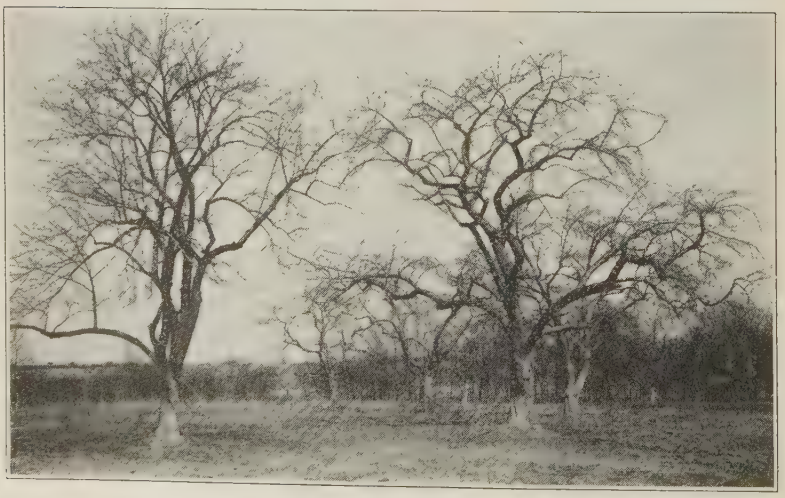


Fig. 20. Typical "sky scraper" trees. They should be "dehorned." If you have an orchard like this, consult the Horticultural Department

Bulletin No. 123. Commercial Melon Growing
Bulletin No. 128. Small Fruits
Bulletin No. 135. Growing Better Gems
Bulletin No. 138. The San Jose Scale
Bulletin No. 144. Growing Tomatoes for the Canning Factory



Fig. 21. Rear view of power sprayer in Purdue orchard. The tops of mature trees can be easily reached from the tower. The power sprayer, though expensive at first, is a money maker for the commercial grower

DEMONSTRATION ORCHARDS

Another method of serving the fruit growing interests of the state is by means of object lesson or demonstration orchards. These are being located in various parts of the state and are managed

under the detailed instructions and personal supervision of the Department. To emphasize the difference between the returns secured by modern management and the returns secured from the ordinary neglect, check plots are left in each demonstration orchard. These receive the same treatment that the whole orchard formerly received. Each orchard serves as a continuous object lesson and



Fig 22. One of the results of bad pruning. The stubs were left too long and were not protected with paint. As a result, fire blight has started at the wounds and nearly killed the tree

center of instruction for the fruit growers of the surrounding country. Already these orchards are having the effect of distinctly improving the orchard practice of neighboring fruit growers. Demonstration orchards are now located at or near Worthington, Seymour, Borden, Guilford, Cambridge City, Logansport and Ft. Wayne.

Among other means of carrying to the people the Department's message of better fruit for Indiana may be mentioned, lectures at farmers' institutes, instruction at short courses, exhibits at state and county fairs and among the most valuable of all, horticultural demonstration meetings. These meetings have now been held in nearly every county in the state and are proving to be of great practical value by introducing and explaining modern methods of fruit growing in the communities where the meetings are held.

The principal lines of work which the Department has now under way or which it has recently completed, have to do with



Fig. 23. Spraying cantaloups. Three sets of nozzles are used covering three rows at a time. The thorough use of Bordeaux will protect the vines from rust and improve the quality of the melons

spraying, orchard management, orchard renovation, setting of new orchards, testing of varieties of orchard fruits, small fruits and some vegetables, onion growing, melon growing, tomato growing, vegetable gardening, post production and nut improvement. Information is available on these subjects, whether in published form or not and personal correspondence is invited from any one interested in these lines of horticulture.

Horticulture in Indiana is now enjoying a distinct revival. The fruit growing interests of the state are being reconstructed, reorga-

nized and endowed with new ideals. New orchards are being set and old ones redeemed. If you are one of the thousands who are just becoming awakened to the possibilities of your own old

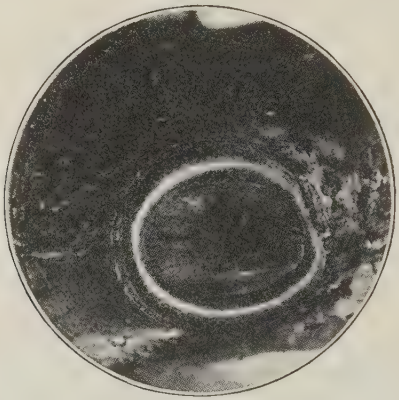


Fig. 24. A good pruning wound,—clean, close and smooth. It is healing rapidly

orchard, if you wish to set a new one, or if you are interested in any phase of the forward movement in Indiana horticulture, you are cordially invited to get in touch with the Department of Horticulture of the Purdue Experiment Station.

SOILS AND CROPS DEPARTMENT

A. T. Wiancko, Chief in Soils and Crops
S. D. Conner, Chemist
M. L. Fisher, Associate in Crops
J. B. Abbott, Associate in Soils
C. O. Cromer, Assistant in Crops

The Soils and Crops Department is primarily concerned in the working out of the most pressing problems of the farm in connection with the handling of soils and the production of crops. Its investigations aim at pointing out the most practical way to proceed in the maintenance of soil fertility, the needs of defective soils, the best use of manures and fertilizers, the improvement of the more important field crops by breeding and selection, the production of maximum crops by the most economical methods, the use of crop rotations and their ultimate effect upon profitable production and the maintenance of soil fertility.

In addition to its investigational work, this department devotes a considerable amount of effort to cooperative fertilizer and crop



Fig. 25. The winter wheat variety tests on Purdue farm

variety tests which yield the farmer direct information on soil and crop subjects in which he is interested. It also carries on a large correspondence with farmers who write in and ask questions about their particular problems. Much information is given out by means of bulletins and other publications, and through lectures and exhibits in cooperation with the Agricultural Extension Department.

The more important lines of experimental work now in progress may be classified as follows:—

1. Comparative tests of various systems of cropping and crop rotation in their relation to profitable production and the main-



Fig. 26. A fine piece of sorghum. The yield was more then 10 tons of green feed per acre

tenance of soil fertility. Such rotation experiments are located in three different parts of the state.

2. Testing different systems of soil improvement on unproductive and run down soils. Such fields are located in three different sections of the state.

3. Testing the fertilizer requirements of different soil types and of different crops. A considerable number of cooperative tests of this kind are carried on in different parts of the state. A special series with potatoes includes a study of the effects of various fertilizer compounds upon the composition and quality of the potato. Another with tomatoes, includes a similar study of the effect upon the canning quality of the crop.

4. The improvement of leading farm crops by systematic breeding and selection, including studies of methods. The corn breeding plots are located in different parts of the state with the object of producing in each case, a type of corn specially suited to the particular section in which the plot is situated.

5. Testing new and prominent varieties of all kinds of farm crops to determine their relative merits for Indiana conditions, to inform farmers which new varieties are worth trying and to



Fig. 27. A good crop of barnyard millet

find new and better foundation stock for crop improvement work.

6. Various crop cultural tests to determine the best methods of planting and tending.

7. Cooperative tests of leading varieties of corn, oats, wheat, cow peas, soy beans and alfalfa. Several hundreds of these tests are distributed over the state, several being located in every county.

Publications. The following list of publications contains something of interest for every farmer. Any of these bulletins or circulars may be had upon application.

Bulletin No. 110. (revised edition) Corn Improvement

Bulletin No. 114. Winter Wheat

Bulletin No.	120.	Soy Beans, Cow Peas and Other Forage Crops
Bulletin No.	149.	Summary of Five Years' Results of Cooperative Tests of Varieties of Corn, Wheat, Oats, Soy Beans, and Cow Peas, 1906-1910
Circular No.	2.	The Selection, Preservation and Preparation of Seed Corn
Circular No.	10.	The Use of Fertilizers on Indiana Soils
Circular No.	23.	How to Grow More and Better Wheat
Circular No.	25.	How to Grow More and Better Corn
Circular No.	27.	Suggestions for Beginners in Alfalfa Culture



Fig. 28. Showing the effect of lime and acid phosphate in securing a stand of clover

STATE CHEMIST DEPARTMENT

W. J. Jones, Jr., State Chemist.
F. D. Fuller, Chief Deputy
E. G. Proulx, Deputy
C. Cutler, Deputy
R. B. Deemer, Deputy
O. S. Roberts, Chief Inspector
J. W. McFarland, Inspector

The citizens of Indiana spend approximately $7,000,000 annually for fertilizers and feeding stuffs.

The administration of the laws regulating the sale of these commodities in the state of Indiana is, by law, entrusted to the State Chemist who is also employed in the settlement of disputes between coal oil dealers and inspectors. The only revenue available for carrying on the work of this department is that derived from the sale of labels and the amount of official work required will not permit of the analysis of miscellaneous materials such as water, rock, soil, etc., either gratuitously or for pay. Information regarding fertilizers, feeding stuffs and related subjects will be promptly furnished but the analysis of samples must be restricted to those taken by the representatives of this department.

FERTILIZER CONTROL LAW

The legislatures of 1899 and 1901 amended the fertilizer law passed in 1881 in order to permit of the analysis of samples taken from consignments of fertilizer actually offered for sale in the state, thereby affording the protection to consumers which it was impossible to secure under the provisions of the fertilizer law of 1881.

In the fertilizer inspection for 1910 our inspectors visited 465 towns in 80 counties and secured in 296 towns 1130 samples, the analyses of 1118 of which are given in detail in Bulletin No. 151.

Of the 1118 samples analyzed 834 or 77 per cent. were "Equal in value to the guarantee" and 1076 or 96 per cent. were "Within 10 per cent. of the value of the guarantee", only 42 or less than 4 per cent. falling into the "Not within 10 per cent." class. Five hundred and thirty-two samples or 46 per cent. had a comparative value of $1.00 or more per ton above the value of the guarantee.

The value of the law to the consumer is emphasized when we compare the preceding with results of the 1899 inspection at which time out of 481 samples analyzed only 39 or 8 per cent. were "Up to the guarantee in every particular," *322 or 67 per cent. were of such a character as to seriously deceive the purchaser* and 221 or 46 per cent. "Not within 10 per cent. of the guaranteed value."

Inasmuch as the use of commercial fertilizer in Indiana is constantly increasing and spreading to all parts of the state the importance to the consumer of the preceding comparison under the original and present law cannot be overestimated.



Fig. 29. Securing official samples

Owing to the fact that labels are good until used and no report of sales is required, it is difficult to determine absolutely the amount of fertilizer used annually in Indiana, but based upon the number of labels sold, the size and amount of packages sampled by our inspectors, we estimate that 151,856 tons valued at $3,695,492 were sold in 1916. Of this amount 60,117 tons were sold in the spring and 91,739 tons in the fall. This is an increase over the sales of 1909 of 17,792 tons or 13 per cent. representing an additional expenditure of $586,228.

The object of the Fertilizer Law being to secure for the consumer the amount and kind of plant food for which he contracts,

and to protect the honest manufacturer against the dishonest one, purchasers of fertilizer should consult the State Chemist's bulletin and buy from companies whose inspection records are such as to justify the belief that they are furnishing fertilizer up to guarantee.

FEEDING STUFF CONTROL LAW

The value of the commercial feeding stuffs on the market cannot be accurately determined by a cursory examination on the part of the purchaser. Therefore in order to protect the farmers and feeders of Indiana against the large amount of adulterated and inferior feeding stuff known to have been sold in the state, the legislature of 1907 enacted a law regulating the sale of this commodity and designated the State Chemist as the executive officer. The requirements of this law have become of great benefit to consumers of feeding stuffs and honest manufacturers may now market their products without fear of competition with adulterated material.

The objects of the law are briefly stated as follows:

1. To have all feeds offered or exposed for sale or sold in the state labelled so that the consumer may have information as to their composition and the materials used in their manufacture.

2. To protect the consumer against adulterated or inferior feeds which up to the time of the passage of the law he had no means of recognizing.

3. To protect the honest manufacturer and dealer against dishonest competition.

4. To inform the consumer as to feeds which are the most economical to purchase and to promote the rational use of feeding stuffs.

During the year 1910 the inspectors from this department secured 2765 samples of feeding stuffs in the open markets of the state, which were later submitted to chemical analysis and microscopical examination. Of the 418 samples of wheat bran analyzed only six samples showed a deficiency in crude protein and none were deficient 1 per cent. Of the 467 samples of standard wheat middlings analyzed only 11 samples showed a deficiency in crude protein, of which four were deficient 1 per cent. or more. Inasmuch as these wheat by-products constitute approximately one-third of the total number of samples analyzed in 1910, it is fair to assume that the feed market in Indiana is in a very satisfactory condition. The average analysis and selling price per ton of the samples of wheat bran was 4 per cent. crude fat, 16.8 per cent. crude protein and $26.21. The average analysis and selling price per ton of the samples of wheat middlings were 4.4 per cent. crude fat, 16.9

per cent. crude protein and $27.21. With one exception the average analysis was slightly higher than that obtained in 1909 with very little increase in the average price per ton.

During the past year very few violations of the law occurred as a result of adulteration and in practically all these cases the adulteration was of a minor character and was promptly rectified by reregistration. Other violations due to non-tagging were satisfactorily adjusted by obtaining proper State Chemist's labels and attaching the same to the balance of the stock unsold. One case, however, deserves special mention, the details of which are as follows:

M. F. Gremelspacher, Walton, Ind., received from J. Lindsay Wells Company, Memphis, Tenn., through Arthur Surber, Indianapolis, Ind., 15 tons of cottonseed meal, Sun Brand, guaranteed in correspondence to contain 41 to 45 per cent. of crude protein. The feed was shipped in plain bags tagged with the private labels of J. Lindsay Wells Company but *without Indiana State Chemist labels* and with a sight draft for $435.00 attached to bill of lading. An official sample of this meal was secured by an inspector and chemical analysis showed only 37.6 per cent. crude protein while the microscope revealed the presence of an undue proportion of cottonseed hulls. The sale of this meal therefore was a double violation inasmuch as it did not come up to the guarantee and was not properly labelled. As soon as this case was reported to the State Chemist he at once requested the J. Lindsay Wells Company to furnish labels to cover the shipment in question. No assurance was obtained that this would be done and it was necessary to look to Mr. Surber to see that the requirements of the law were complied with. Mr. Surber at once registered this meal under his own brand and the proper State Chemist labels were forwarded Mr. Gremelspacher to cover the 15 tons purchased from him with instructions to furnish each member of the club, for which he was acting as agent, a sufficient number of labels to cover the cottonseed meal received by them. Furthermore, as this meal was purchased on a guarantee of 41 per cent. crude protein the approximate cost per unit of protein was 70 cents. The deficiency shown was 2.4 per cent. crude protein making the rebate to Mr. Gremelspacher $1.68 per ton or $25.20 on the 15 tons shipment. Under date of April 6, 1911, Mr. Gremelspacher upon receipt of $25.20 from Arthur Surber agreed to accept same in full settlement for deficiency in value of cottonseed meal purchased from Mr. Surber in November, 1910, and further agreed to settle in full with all parties to whom he sold a part of this order of cottonseed meal.

The case cited above is typical of what is being accomplished by this department for the benefit of the farmers and feeders of Indiana and what is true in the case of feeding stuffs is equally true in connection with fertilizers.

ADMINISTRATION

As stated above the fertilizer and feeding stuff laws are administered by the State Chemist and his deputies and the official business of the department is limited to the inspection of fertilizers and feeding stuffs and the settlement of disputes between coal oil dealers and inspectors. The only funds available for carrying on the work of the Department are those received from the sale of labels and the revenue and official staff will not permit of the analysis of miscellaneous samples.

Inspectors sent out from the State Chemist's office are on the road throughout the year taking samples of fertilizer and feed which samples are forwarded to the laboratory where they are submitted to analysis by a force of competent chemists. These samples are analyzed in the order in which they are received at the laboratory and on completion of the analysis a report is sent to the person or firm registering the fertilizer or feed and to the agent, dealer or consumer from whom the sample was obtained. Consumers are requested to note that the only official inspections permissible under the law are of samples taken by the inspectors from this department. In case an inspection is desired do not send a sample but address the State Chemist giving the official number and the amount of fertilizer or feed on hand and if the amount is sufficient to furnish a fair sample and the brands have not been repeatedly analyzed an inspector will be sent to take a sample without cost to the consumer.

On May 4, 1911, this department received a commission from the United States Department of Agriculture, to collect samples of feeding stuff and other products as defined in the Indiana Feeding Stuff Law which are manufactured or offered for sale in the District of Columbia or in any territory of the United States or which shall be offered for sale in unbroken packages in any state other than that in which they shall have been respectively manufactured or purchased, for examination under the direction or supervision of the Bureau of Chemistry at Washington, D. C. We are certain that cooperation between the departments will be of great advantage especially to consumers of feeding stuffs in Indiana.

The results of the inspection of fertilizers and feeding stuffs in 1910 will be found in Bulletins No. 151 and No. 152.

VETERINARY DEPARTMENT

R. A. Craig, Chief in Veterinary Science
H. H. Madaus, Ass't in Serum Laboratory
R. A. Whiting, Associate in Animal Pathology

For a number of years the work of this department has been the investigation of hog cholera. The early work consisted in investigating outbreaks of the disease in different parts of the state. Methods of treatment and control were given special study. The farmers were instructed as to the best methods of preventing the spread of the disease, and the uselessness of treatment with a number of the so-called hog cholera cures was demonstrated by field tests. A study of the disease in the laboratory was an important part of the investigation work.

It was not until 1909 that the Experiment Station was able to offer a reliable method of vaccinating hogs against cholera. This is usually termed the serum-simultaneous method. It consists in injecting hog cholera blood and serum beneath the skin or into the muscles, usually, of the inner thigh region. The quantity of serum and virulent blood injected varies according to the size of the hog.



Fig. 30. The serum laboratory

During the past year the average dose was 40 c.c. of serum and less than 1 c.c. of virulent blood.

Serum is usually used as a preventive and not as a curative agent. It may be used in preventing loss in recently infected herds, but the results are uncertain when used in the treatment of hogs that show marked symptoms of hog cholera. In all herds vaccinated



Fig. 31. Bleeding hyperimmune hogs

or treated it is necessary to take the body temperatures of the hogs in order to separate the healthy from the diseased animals.

During the year ending June 30, 1909, 120,000 c.c. of hog cholera serum were produced, and the following year 140,000 c.c. During the past 10 months about 1,200,000 c.c. were produced. Altogether, more than 40,000 hogs have been vaccinated and treated. The demand for serum has exceeded the quantity produced, and this condition cannot be remedied until sufficient financial support is given the work.

Hog cholera serum is distributed through the veterinarians. The veterinarians are charged one cent per c.c. and a small cost for packing, and the farmer is charged one and one half cents per c.c., the one half cent representing the veterinarian's fee for the work.



Fig. 32. Vaccinating a hog

SCHOOL OF AGRICULTURE

JOHN H. SKINNER, Dean

PURPOSE

The purpose of the School of Agriculture is to give young men and women a broad, well rounded education that will fit them for the business of farming and other important questions, as well as for the highest type of citizenship.

EQUIPMENT

The equipment used in teaching agricultural subjects consists of *Agricultural Hall,* a two story brick and stone building containing soils, crops, dairy, horticultural, and veterinary laboratories and class rooms, and a modern creamery, a large assembly room, and a room for the Agricultural Society, herd book library and offices for members of this department; a *Farm Mechanics* building in which are located drawing rooms, class rooms, and laboratories devoted to heavy and light farm machinery and cement work; a modern *Dairy Barn* exemplifying proper ventilation, lighting, drainage, and facilities for the production of a sanitary herd; a large *Live stock Judging Pavilion* with ample light and seating capacity, tan bark arena, class room, demonstration rooms in which the various practical phases of judging and handling live stock are studied; a well equipped *Farm* devoted to experimental work in animal husbandry, dairying, poultry, soils and crops, orcharding and gardening, and the practical handling and management of live stock and poultry; an excellent herd of pure bred beef cattle, dairy cattle, swine, and flocks of sheep representing the most important pure breeds which afford ample specimens for instructional purposes.

INSTRUCTION

The instruction in Agriculture is practical and thorough, consisting of recitations, lectures and laboratory work in which agricultural science and practice are systematically taught. The student deals with the common every day problems of the farm, works with soil, plants, live stock, fertilizers, and dairy products, and is constantly working with the things with which he comes in contact on the farm. Agricultural students analyze soils, study crop rotations and production, judge grains, handle and judge live stock, study

selection, feeding, breeding, production and care of live stock, practice grafting, budding, and pruning, judge fruits and vegetables, study the life history, characteristics and habits of insects and fungi and methods of preventing their ravages, make up mixtures for spraying, test grains and other seeds, adjust and operate farm machinery, separate and test milk, make butter and cheese, and study the production and care of dairy products, and thus secure practical knowledge of these various farm products and operations.

Young men and women will find the agricultural courses a most profitable investment as they will not only be a great source of satisfaction but will enable those who complete them to attain the highest degree of success as farmers, teachers, investigators, and business men in commercial agriculture.

The Department of Agriculture consists of several branches as follows: Agronomy, Animal Husbandry, Dairying, and Horticulture, to which a large corps of instructors devotes its time.



Fig. 33. Studying the physical properties of soils. The maintenance of soil fertility is the most important economic problem confronting farmers

AGRONOMY

Professor Wiancko in charge
Professors Latta and Fisher
Assistant Professor Nye (Farm Mechanics)
Assistant Professor Conner (Agricultural Chemistry)
Instructor Craig
Assistant Bracker

The instruction in this department deals with soils, crops, farm mechanics, and general farm management by means of class room and laboratory exercises in such a way as to give the student a good working knowledge of how to properly and at the same time more profitably carry on farming operations. The everyday needs of the farmer are always prominently kept in mind. The instruction includes the principles involved and the best practices followed in the maintenance and improvement of soil fertility; how to find out what the soil needs; the value, uses and application of various manures and fertilizers; the important characteristics of various types of soil, the improvement of soils in poor physical condition, the location and construction of drainage systems, the best preparation for different crops; seed selection, including corn and other grain judging, testing and grading; the best cultural methods for all kinds of farm crops; the planning and construction of farm buildings; the uses of cement on the farm; fencing materials and fence construction; the operation and care of all kinds of farm machinery; farm economics and the practical business of farm management and profitable production.



Fig. 34. Students making cement fence posts

ANIMAL HUSBANDRY

Professor Skinner in charge
Professor Craig (Veterinary Science)
Assistant Professor Smith
Instructors Allen and Gobble

The courses given by this department are calculated first, to give an understanding of the fundamental principles of breeding, feeding, and care and management of all classes of live stock, and second, to supply laboratory training in all the practical phases of the subjects not afforded by ordinary farm practice. Instruction is given in the history and characteristics of the various breeds of live stock; principles and practice of breeding; animal nutrition and feeding; live stock management; herd-book study; veterinary anatomy and physiology; veterinary medicine and surgery. Much time is devoted to the subject of live stock judging. The new stock judging pavilion and representatives of nearly all the common breeds and classes of live stock on the farm, supply excellent equipment for this work.



Fig. 35. Class judging different types of sheep. The selection of breeding animals is an important matter often neglected on the farm

POULTRY

The poultry work is given for the purpose of teaching students the best methods of poultry management and to prepare them for teaching and experimental work. The course consists of instruc-



Fig. 36. Short course and Freshmen students attending poultry dressing demonstration

tion in all lines, such as housing, breeding, feeding, incubation, brooding, diseases, etc., accompanied by laboratory practice. The equipment consists of a 17 acre farm belonging to the Experiment Station, that is well equipped for teaching this work.

DAIRY HUSBANDRY

PROFESSOR HUNZIKER in charge
INSTRUCTORS JARVIS and CRANE
ASSISTANT ROBERTS

The instruction in this department deals with the dairy cow and her product. It is intended to train the student in the knowledge and practice of economic and sanitary milk production (how to select, breed and feed dairy stock for profit); the care and management of the dairy herd; judging dairy cattle; the secretion, composition, properties and ferments of milk; city milk supply; farm and creamery buttermaking; creamery management, accounting and machinery; cheese making; the manufacture of condensed milk, ice cream, fermented milks, dried casein and miscellaneous products; testing milk and its products for purity and composition; state and federal dairy laws and milk and dairy inspection.

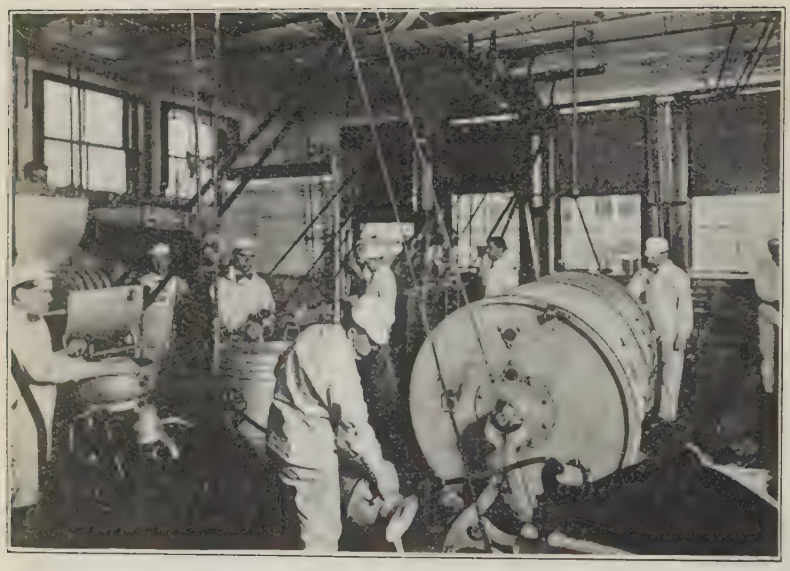


Fig. 37. Students doing practical work in the creamery where commercial methods are taught



Fig. 38. A class judging dairy cows—training the students to select economical producers by a study of conformation

HORTICULTURAL DEPARTMENT

Professor Troop in charge
Professor Woodbury
Instructor Boyle

Two main lines of horticultural work are available to students in the School of Agriculture. One line is general in its nature and is designed primarily for the benefit of students who expect to go into general farming. The other is more highly specialized and is designed to meet the needs of students who expect to engage in some branch of commercial horticulture or college and experiment station work.

In the general course, fruit growing is studied in its relation to general farming and the farm home. Lectures and laboratory work



Fig. 39. A demonstration in top grafting before a class of horticultural students. The orchard is utilized as an out-door laboratory for practical instruction

are given covering the subjects of location and care of orchards, spraying, pruning and orchard management.

The horticultural work for students specializing in this subject is more complete. The tree fruits and small fruits are taken up in detail and studied in both field and laboratory. The student is given training in the propagation of fruits, the details of orchard management, the protection of fruit from insect and disease attacks



Fig. 40. Students preparing hotbeds for growing plants for their own gardens. "Learn by doing" is the key note of horticultural instruction

and in the identification of varieties. Landscape gardening is studied in its relation to the rural home, the small park and the school grounds. Courses in vegetable gardening are given in which the student is required to prepare the soil, produce the plants and grow the crop. The courses in horticulture have been materially strengthened during the past season so that now both more horticultural instruction and better facilities for horticultural work are available than ever before.

DEPARTMENT OF AGRICULTURAL EXTENSION

G. I. Christie, Superintendent
W. C. Latta, Farmers' Institute Specialist
G. M. Frier, Small Seed Specialist
Gertrude McCheyne, Lecturer in Domestic Science
Lovina S. Merick, Seed Analyst

The Agricultural Extension Department has for its main object the advancement of agriculture, domestic science and rural life in Indiana. It aims to carry to the people of the state helpful information, and secure its application in the daily practices on the farm and in the home.

The Department of Extension is organized so as to furnish the necessary machinery for the projection of the results of the work of the Agricultural Experiment Station and the School of Agriculture and agriculture in general.

The various departments of the Station and School cooperate in carrying on the several lines of work by assembling the information to be projected and by furnishing men to give the instruction.

The movements forwarded have been popular and have reached large numbers of people in an effective way. That the people favor a continuance and increase of extension work has been shown by the passage of the Clore Bill by the recent Indiana legislature. Under this act, the scope of the work of the Department is enlarged and will consist "of a study of rural conditions and in promoting and aiding in the organization and holding in various parts of the state, farmers' short courses, farmers' institutes, farmers' conferences, contests, lectures and demonstration work of various types, and any other form of instruction and demonstration agreed upon by the authorities of Purdue University."

FARMERS' INSTITUTES

Farmers' institutes have been a most important medium through which Indiana farmers have been reached. The help, in the way of inspiration and information, given by speakers sent out by this agency, has reached many thousands of farmers and their families each year, and has done much for the improvement of agriculture and the farm home.

Forty-seven assigned speakers gave instruction the past winter at 282 farmers' institutes. Every county was reached with from one to nine meetings, and the total attendance for the state, was 201,580.

The institute work will be continued. The number of meetings will be increased, and the work made of the greatest interest and value. Every community should hold annually a live enthusiastic farmers' institute.

SHORT COURSES

During the past year farmers' short courses have been held at several points in Indiana. The object has been to give advanced



Fig. 41. Farmers judging corn, District Short Course, Huntington, Ind.

instruction, and at the same time, make it as practical as possible. The work has consisted of lectures, supplemented with practical exercises in corn judging, stock judging, poultry judging, butter scoring, fruit judging, making of spray mixtures, domestic science demonstrations, etc.

The attendance at the courses held was as follows:

Lowell	400
Reynolds	350
Huntington	800
Evansville	1700
Terre Haute	600
Richmond	750

The demand for similar work for the coming year is now very large. An attempt will be made to meet this demand and short courses will be held at a large number of points in the state.

EDUCATIONAL TRAINS

Railroad corporations appreciate more and more that the carrying out of information from the State Agricultural Experiment Station to the farmer is a necessary work and one in which they can take part. Anything that tends to increase the production of the soil, increases the freight business.

Several railroads have, therefore, cooperated with the Agricultural Experiment Station in the running of special educational trains over their lines in Indiana. The lectures given on these trains have been well received by large enthusiastic crowds of farmers at every stop. The special train affords a great opportunity for the University to place special information before large numbers of farmers in an effective way, in a short time and at a small expense.

During the past year two special trains were run:

Penn. Lines—Wheat Train—August 22-September 7, 1910
Attendance—14,700

L. E. & W. R. R.—Corn Train—April 25-29, 1911
Attendance—5,000



Fig. 42. Ready for the start. A special educational lecture train

SEED LABORATORY

The Bureau of Plant Industry of the United States Department of Agriculture has established in connection with the Extension Department a Branch Seed Laboratory. This laboratory is designed to serve the farmers and seedsmen of the state. Samples of seeds, clover, alfalfa, timothy, bluegrass, or other farm and garden

seeds, are received at this laboratory, tested and reported upon free. A comprehensive detailed report of purity, together with the results of an actual germination test, is made on all samples of seed submitted. Since the opening of the laboratory, little more than a year ago, more than 1320 samples have been examined and reported upon.



Fig. 43. Farmers rushing into cars to hear lectures

DOMESTIC SCIENCE DEMONSTRATIONS

Women, as well as men, are receiving help through the Extension Department. Women thoroughly trained in domestic science have been sent to different points in the state to give lectures and practical demonstrations in household economics. In this work an attempt has been made to demonstrate the principles underlying the preparation and cooking of foods, care and clothing of the body, feeding and care of children, etc. Help is also being given in the planning and working out of courses in domestic science in the schools of the state.

This department is also doing much to forward baking, sewing, fruit canning and other educational contests for girls and women of the state.

Through these several mediums much interest is being aroused and a great good accomplished. During the past year 33 demonstrations have been held with an attendance of more than 3852.



Fig. 44. Two Hundred fifty school teachers listening to a lecture on wheat improvement, Winchester, Ind.

EXHIBITS

County Fairs.—A county fair exhibit, showing in an interesting, attractive and forceful way the work of the School of Agriculture and the Experiment Station has been prepared. The exhibit consists of 14 boxes, each five feet long and three feet wide. In these boxes, are photographs, charts, specimens of diseased tissue and plants, spraying apparatus, Babcock milk testers and other materials which present the work of animal husbandry, dairying, horticulture, soils and crops, veterinary and botany. These exhibits are strictly educational and have taken a prominent place at more than 14 county fairs this past year.

The fairs visited in 1910 are as follows: Osgood, Middletown, Greensburg, Fairmount, Lawrenceburg, Frankfort, LaFayette, Rochester, New Harmony, Lebanon, Columbus, Franklin, Crawfordsville and Bourbon, with a total attendance of 273,000 people.

State Fair.—A mammoth educational exhibit was placed in the Purdue Building at the State Fair last fall. Every department of the Station and School was represented in a strong way and the work met the approval of all visitors. Many thousands of farmers visited and studied the exhibits, met the men in charge and became better acquainted with work at Purdue.



Fig. 45. Small seeds should always be examined for weed seeds and other impurities

HORTICULTURAL DEMONSTRATIONS

With the idea of stimulating interest in fruit growing and giving information as to best methods of making and applying spray mixtures, pruning of trees, etc., horticultural demonstrations were held in several counties of the state.

These meetings were attended by large numbers of people and it is felt that much was accomplished for the growing of more and better fruit.

The meetings were held at Fairmount, Mentone, Culver, Valparaiso, Wolcottville, Huntertown, Centerville, Madison, Seymour, Salem and Rockville, with an attendance of more than 1305 people.

RURAL SCHOOL AGRICULTURE

With the increasing interest in the teaching of agriculture in the rural schools of Indiana, comes an increased demand for help from school teachers. To meet this demand, bulletins have been furnished, weed seed collections have been supplied and other helps given.

In connection with the district short courses, teachers' institutes and other meetings, a two days' course for teachers has been given. The instruction in these courses consisted of practical



Fig. 46. County corn club boys inspecting and judging horses at the LaFayette Stock Farm

demonstrations of methods of teaching agriculture. This work has been appreciated and has done much to forward the teaching of agriculture in the schools. During the coming year, special attention will be given by this department to teachers who wish to do some agricultural work.

CONTESTS

Contests for young people have been recognized as a valuable medium through which boys and girls may be directly interested in agriculture. Special attention has been given to this movement and large numbers of boys and girls have been enlisted in corn growing, live stock judging, bread baking, sewing, fruit canning and other contests.

The Extension Department is ready to give material aid to the contests in the way of literature, judges, lectures, etc. Organizations interested in this movement should apply for information and help.

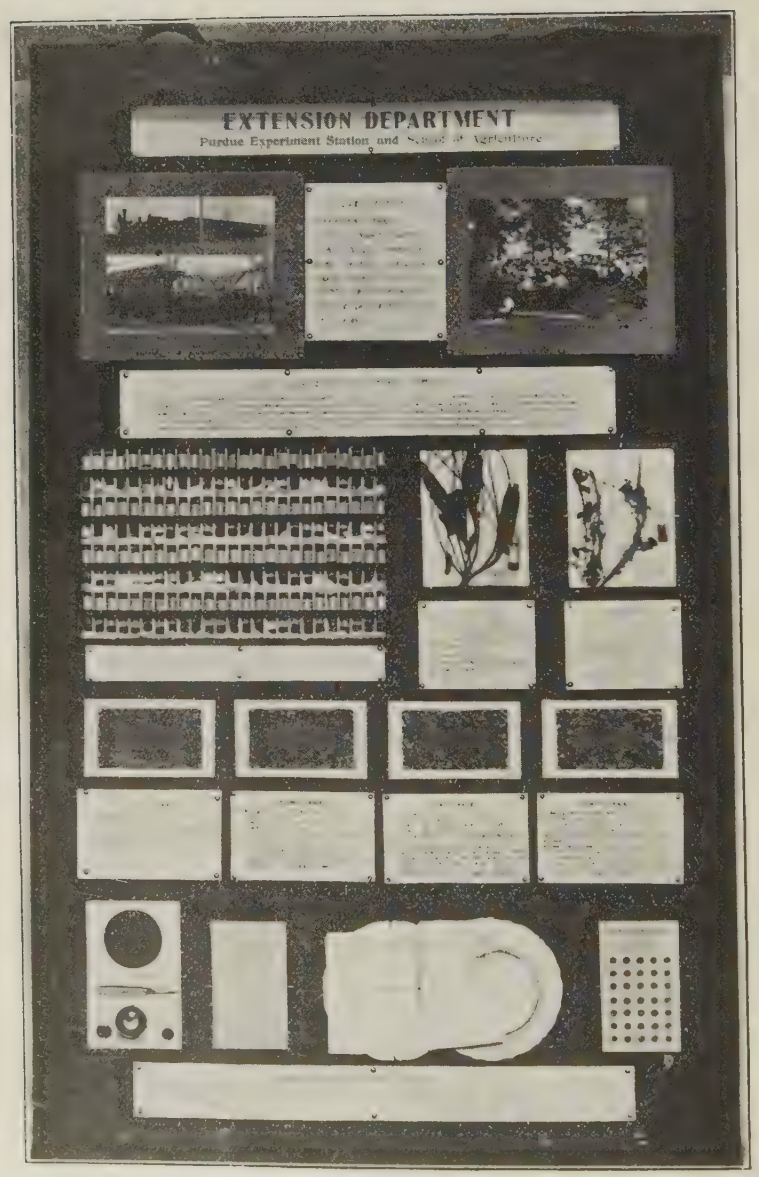
UNIVERSITY CALENDAR

Fall entrance examinations begin September 6, 1911

The Four Year Course will begin September 13, 1911

The Farmers' Short Course will be held early in January, 1912

The Winter School of Agriculture will open in January, 1912



One of the 14 boxes of the Purdue University county fair exhibit

PURDUE UNIVERSITY
Agricultural Experiment Station

Circular No. 29
(Revised Edition)

LaFayette, Ind., July, 1912

AGRICULTURAL EXTENSION
XII

LIVE STOCK JUDGING FOR BEGINNERS

To become a good judge of live stock should be the ambition of every boy and girl. This circular is designed primarily for the beginner in the study of live stock judging, and more especially for the boys and young men of Indiana who cannot come into personal contact with any one familiar with a systematic method of studying this subject.

Indiana farms need more and better live stock in order to prevent the waste of large quantities of rough feeds and to maintain soil fertility and increased profits.

The farmer who has become a good judge of live stock through careful, systematic study will have opportunity to come in touch with the best methods of breeding and handling stock and with men of affairs, and by his increased knowledge broaden his influence and usefulness to his community and the world at large.

The man who understands market demands and who has the ability to select animals for the feed lot, that will make consistent, rapid, and economical gains throughout the feeding period and meet the market requirements will find this knowledge a source of both profit and satisfaction.

Wise selection and mating is impossible without definite knowledge of what constitutes a good animal and ability to discriminate against the undesirable, inferior sire.

It is not practicable nor possible to replace all the live stock of the farms of Indiana with pure-breds. It is possible, however, and would be highly profitable, to replace all the grade, cross-bred, and scrub males which are being used as sires, with males which possess the breeding that will insure improvement.



Fig. 1. Judging draft horses. Winter Course contest, 1911



Fig. 2. Judging sheep. Winter Course contest, 1911

LIVE STOCK JUDGING FOR BEGINNERS

This circular was prepared under the direction of J. H. Skinner, Professor of Animal Husbandry, by members of the Departments of Animal Husbandry and Dairying, and edited by D. O. Thompson.

TABLE OF CONTENTS

Part I.—Introduction — Page

- The Study of Live Stock Judging is Profitable — 6
- The Score Card — 8
- Comparative Judging — 10

Part II.—Judging Horses. By D. O. Thompson, Animal Husbandry Extension

- Introduction — 12
- Draft Horses — 12
- Harness Horses — 26
- Saddle Horses — 30
- Ponies — 31
- Breeding Classes — 32
- Location of Common Unsoundnesses and Faults — 35

Part III.—Judging Beef Cattle. By F. G. King, Associate in Animal Husbandry

- Introduction — 40
- Fat Steers — 40
- Feeder or Stocker Cattle — 49
- Breeding Classes — 51

Part IV.—Judging Dairy Cattle. By P. H. Crane, Associate in Milk Production

- Introduction — 56
- The Dairy Cow — 60
- The Dairy Bull — 73

Part V.—Judging Hogs. By W. W. Smith, Assistant Professor of Animal Husbandry

- Introduction — 76
- Fat Hogs — 76
- The Brood Sow — 83
- The Boar — 85

Part VI.—Judging Sheep. By H. E. Allen, Assistant Professor of Animal Husbandry

- Introduction — 88
- Fat Sheep — 91
- Feeder Sheep — 110
- Breeding Classes — 111
- Merino or Fine-wool Type of Sheep — 113

Appendix

- A Method of Live Stock Improvement. By W. W. Smith — 115
- Tabulation of Breeds of Live Stock — 118
- Age of the Horse. By R. A. Craig — 123
- Books about Live Stock — 126
- Bulletins about Live Stock — 126
- Acknowledgements — 127

ILLUSTRATIONS

		Page
1.	Judging Draft Horses; Winter Course Contest, 1911	2
2.	Judging Sheep; Winter Course Contest, 1911	2
3.	Points of the Horse	14
4.	Correct Position for Estimating Height of Horse	15
5.	Muscular, Compact, Low-set, Draft Conformation	16
6.	A "Good Outlook"	18
7.	Weak, Sickle-shaped Hocks	21
8.	Straight, Upright Pasterns, Showing Cocked Ankles	21
9.	Judging Action: Horse Moving Away at the Walk	23
10.	Judging Action: Horse Returning at the Walk	23
11.	Judging Action: Horse Moving Away at the Trot	24
12.	Judging Action: Horse Returning at the Trot	24
13.	Judging Action: Horse Moving Past at the Walk	25
14.	Judging Action: Horse Moving Past at the Trot	25
15.	Strength: Fore Legs of Drafter	27
16.	Speed: Fore Legs of Roadster	27
17.	Heavy Harness Horse	28
18.	Light Harness Horse	29
19.	Quality, Style, and Spirit	30
20.	Popular Type of Saddle Mare	31
21.	Type of Shetland Pony in High Demand	32
22.	Draft Mare	33
23.	Farm Mare	34
24.	Buck Knees	35
25.	Poll Evil	37
26.	Fistula of the Withers	37
27.	Collar Boil	37
28.	Shoe Boil	37
29.	Navicular Disease	38
30.	Ring Bone	38
31.	Bone Spavin	38
32.	Incomplete Toe Cracks	39
33.	Extreme Case of Quarter Crack	39
34.	Knock Down Hip	39
35.	Wholesale Cuts on the Beef Carcass	41
36.	Wholesale Cuts Located on the Live Steer	41
37.	Ideal Fat Steer	43
38.	Points of the Beef Animal	44
39.	Points of the Beef Animal	44
40.	Points of the Beef Animal	45
41.	Fancy Selected Feeder	50
42.	Inferior Feeder	51
43.	Hereford Cow	52
44.	Shorthorn Bull	53
45.	Angus Cow	54
46.	Adherence to Breed Type Indicates Prepotency	55
47.	Uniformity Adds to the Value of the Breeding Herd	55
48.	Arteries and Veins Leading from and to the Heart and Udder	57
49.	A Poor Type of Dairy Cow	58
50.	Wedge Shape as Seen from the Side	59
51.	Wedge Shape as Seen from Above and Behind	60

		Page
52.	Wedge Shape as Seen from the Front	61
53.	Points of the Dairy Cow	62
54.	Method of Estimating Width of Chest Floor	65
55.	A Well Developed Udder	67
56.	Method of Estimating Length of Udder Attachment	68
57.	Udder Well Attached Behind	68
58.	A Pendulous Udder	69
59.	A Funnel Shaped Udder	70
60.	Method of Determining Size of Milk Well	71
61.	Method of Examining Quality of Hide and Hair	71
62.	A Pure-Bred Dairy Bull	73
63.	A Grade Bull	74
64.	Wholesale Pork Cuts	77
65.	Wholesale Cuts of Pork Located on Live Hog	77
66.	Points of the Hog	78
67.	A Typical Brood Sow	84
68.	The Extreme Lard Hog Type. Boar	86
69.	The Bacon Type. Boar	87
70.	A Good Mutton, Medium Wool Type	88
71.	A Good Mutton, Long Wool Type	89
72.	A Good Fine Wool Type	89
73.	Points of the Sheep	92
74.	Points of the Sheep	92
75.	Position from Which to Note General Appearance and Type	94
76.	Ram Lamb Before Trimming	95
77.	Ram Lamb After Trimming	95
78.	Mutton and Lamb Cuts	96
79.	Mutton Cuts Located on Live Sheep	97
80.	Typical Mutton Head	99
81.	Method of Examining the Neck	100
82.	Method of Noting the Depth of Chest and Width of Breast	100
83.	Method of Noting the Width of Chest	102
84.	Method of Feeling Top of Shoulder	102
85.	Method of Judging the Loin	103
86.	Before Shearing, the Hand Must be Used to Judge	103
87.	After Shearing, the Eye May Judge	103
88.	Method of Determining Length of Rump	104
89.	Method of Noting Width of Rump and Fullness of Thighs	104
90.	Method of Judging the Leg of Mutton	105
91.	Well Developed Hind Quarters of Mutton Lambs	105
92.	Fat Lambs Finished for the Market	106
93.	Manner and Place of Opening Fleece for Best Wool	108
94.	Manner and Place of Opening Fleece for Poorest Wool	108
95.	Flock of Breeding Ewes	112
96.	Good Breed Type and Mutton Qualities	113
97.	Good Breed Type and Fine Wool Qualities	114
98.	Diagram of Tooth (two views)	124
99.	Slope of Teeth at Five Years	124
100.	Slope of Teeth at Twenty Years	124
101.	Temporary Incisors at Two Years	125
102.	Permanent Incisors at Five Years	125
103.	Permanent Incisors at Nine Years	125
104.	Permanent Incisors at Twelve Years	125
105.	Permanent Incisors at Fifteen Years	125
106.	Judging Beef Cattle; Winter Course Contest, Purdue	128

PART I

INTRODUCTION

THE STUDY OF LIVE STOCK JUDGING IS PROFITABLE

The knowledge gained by such study will be a source of satisfaction and financial profit throughout life. Wise buying and selling, proper selection of stock for breeding and feeding purposes, a knowledge of the excellence of your animals and their value, acquaintance with the market classes, and a more intelligent interpretation of market quotations, will aid you in placing your live stock business on a firmer, more profitable basis. Combining definite knowledge with your business means that you will make and save more money than would otherwise be possible.

Every country boy and girl should be interested in good stock and know how to properly care for it. Good live stock on the farm is a continual source of profit and satisfaction. To become a good judge of animals should be the ambition of every boy and girl. There are few more interesting studies than the study of animal life and with the assistance of your parents, your teachers and others, and the many books, agricultural papers, and bulletins of your Agricultural College and Experiment Station and the United States Department of Agriculture now published, any one may obtain a knowledge that will be invaluable to him. Indiana farms need more and better live stock in order to prevent the waste of large quantities of rough feeds and maintain soil fertility and increased profits.

Every farmer who keeps live stock must meet the problem of selecting females to be used in his breeding herd or flock; however, a more difficult problem is the selection of males suited to produce best results when mated with them. Wise selection and mating is impossible without definite knowledge of what constitutes a good animal and ability to discriminate against the undesirable, inferior sire. Through long experience, filled with costly mistakes and equally costly triumphs, some men have learned the art of selection and mating. A careful, systematic study of live stock will enable you to obtain what these pioneers in breeding have discovered by costly experience and the expenditure of much time and money. The successful breeders of pure-bred[1] live stock in the future must

[1] Pure bred; stock whose ancestors are registered or eligible to registry in a recognized registry association. Grade: stock, the offspring of pure bred sire and non-pure bred dam. Scrub: stock having neither parent of pure breeding is said to be of scrub breeding: or, the get of a sire of impure breeding: or, inferior stock

necessarily understand the science of selection and mating and be able to put their knowledge into practice early in life without experimenting for years as has been the case with our forefathers. In other words, they must begin where their fathers quit, and improve our present flocks and herds which have already reached a high state of development. Live stock shows of local, state and national character afford an excellent medium for advertising breeding stock. The knowledge and ability to select animals that will develop into show stock will largely determine an exhibitor's success in the show ring. The breeder who is a good judge of animals and who has the knowledge of show ring standards is in a position to determine whether his stock can successfully compete in the shows.

The man who understands market demands and who has the ability to select animals for the feed lot that will make consistent, rapid, and economical gains throughout the feeding period and meet the market requirements, will find this knowledge a source of both profit and satisfaction.

The farmer who has become a good judge of stock through careful, systematic study will have a degree of recognition and influence in his community that may offer many opportunities for him to meet and mingle with the best informed live stock men, expert judges, prominent breeders and officials of shows and other agricultural organizations. He may thus come in touch with the best methods of breeding and handling stock and with men of affairs, and by his increased knowledge broaden his influence and usefulness to his community and the world at large.

As indicated in the title, this circular is designed primarily for beginners in the study of live stock judging, and more especially for the boys and young men of the state who can not come into personal contact with any one familiar with a systematic method of studying this subject. A considerable amount of detail, therefore, necessary to the automatic action of the circular as an instructor in live stock judging, has been inserted. This may appear superfluous to the more advanced student and to the experienced stockman and judge, who may, at their pleasure, dispense with its perusal. Beginners, however, will derive from the careful study of the introductory sections, information enabling them to more fully comprehend and follow subsequent instructions and suggestions.

THE SCORE CARD [1]

Its Purpose.—The score card is primarily an aid to the study and teaching of stock judging. It is a detailed description of the parts of an ideally perfect animal, giving in systematic order all of these parts, and emphasizing their relative importance. It teaches the method of seeing the various parts in a logical, orderly way. It deals with one animal, comparing it with an ideal of what the animal should be. After learning the method of examination, the art of seeing the parts of the animal instead of merely the animal as a whole, and securing an idea of the relative importance of these parts, you are ready to discard the score card, and take up comparative judging.

Its Make-up.—A comparison of the score cards given in this circular shows that they are all made up in nearly the same way. At the top of the card at the left is given the kind and at the right the class of animals for which the card is made. All the cards are divided into several main divisions, and these again divided into a number of sections. The different parts of the animal are listed and described. At the right of each description is given a figure which shows the percentage value attached to each particular part.

How To Use It.—If the animal is as nearly perfect in any part as is possible, place in the column headed "Student's Score" the figure in the column headed "Standard" and the point will 'go full,' which means that it is worth in your judgment all the card allows. If the part is not good, make a 'cut,' or take away from the percentage given in the standard an amount which will show just how bad you think it is, or how much it would have to be improved to be perfect. Never make a 'cut' of less than one-fourth of one per cent. Seldom will a part of an animal deserve a 'cut' of more than 50 per cent. of its value. An important part deserving more than a 50 per cent. 'cut,' is so seriously at fault that it may disqualify the animal. Then put in the column headed "Student's Score" the percentage value you think this part of the animal to be worth. Start the examination at the first part mentioned on the score card and continue until all parts have been noted in the order given. You will then have recorded in the column "Student's Score" the percentage value of each part by points. Add this column and the total is the score of the animal. Scoring many animals of a class and comparing scores with those of a good judge, and talking with him

[1] *Scoring* is the act of systematically examining an animal and recording on a score card the figure representing the degree of perfection in every part. *Judging* is generally applied to the act of selecting and arranging in the order of their merit the animals in a group entered in public competition. *Selection* is generally applied to the act of choosing breeding, feeding, or show stock

about the points of difference is a good way to learn how to value the weak and the strong points.

A Good Score.—The perfect animal—one filling in every way the description given in the score card—should have a score of 100. It takes a very good animal to score 80, and an exceedingly choice one to score 90. It is impracticable to work out a mathematical system for making 'cuts.' Because the 'cuts' made must depend upon the scorer's judgment, rarely will two scores for the same animal made by two persons be alike in all details, or even in the total score. Two good judges may differ several per cent. in the score allowed an animal, and still both hold about the same opinion of the relative degree of perfection of the animal.

Students' Score Cards.—The score cards given in this circular are those used in class work by the Animal Husbandry and Dairy Departments of Purdue University School of Agriculture to aid in teaching the subject of live stock judging. They are made so that breed characters are not taken into account. The animal is scored from the standpoint of the *use* to which it is to be put. The parts named are those which go to make up perfect animals from a utility or market standpoint. It would not be practicable nor possible to have one score card which would do for use in the study of all the different breeds of the same kind of animals, because in studying the breeds and learning to judge them, those points showing the difference in breeds must be considered. All animals of a kind which are meant to do exactly the same work, or intended to serve in the same way, may well be studied by one score card—the standard for the animal best fitted to do that work or serve that purpose.

Breed Standards.—These have been adopted by nearly all of the national associations for the registration of pure-bred live stock, and may be found in the books of record. Much valuable descriptive matter may be obtained from these associations upon request. In judging from the breed standpoint, base decisions upon trueness to breed type as described in the breed standard. On pages 119 to 124 inclusive tables are given showing the breeds of horses, cattle, hogs, and sheep, the country of their origin, some of their characters and uses, the names of the associations in which they are registered in the United States, the name and address of the secretary of each.

The Way to Study.—In order that you may study live stock scoring and judging in an easy, reasonable way, taking the different things in their proper order, the following steps are outlined:

1. Learn where the points mentioned in the score card are located on the animal.

2. Learn the different uses to which these animals are put, and class them according to uses.

3. Study the score card for one of these classes. Learn what the words used in describing a part of the animal mean. Fix an ideal in your mind and learn to recognize when and wherein any animal departs from that ideal.

4. Score a large number of animals of this class. Comparison with the scores of a good judge whenever possible will help in this practice. Several beginners scoring the same animal and then comparing their scores and discussing them, will help each other where it is not possible to have a competent judge or instructor do the scoring.

5. Study the descriptions of animals of this kind which are put to a different use than the above and which are classed differently. For example: after making a thorough study of the *draft* horse, and fixing that ideal firmly in your mind, take up a study of the *harness* horse, then the *saddle* horse, and so on.

6. Get from the secretary of the registry association for the breed of live stock which you know the most about, a good description of the breed, and study carefully. Know one breed well; few men become an authority on many.

7. After studying the full grown animal, study animals of different ages of the same breed, noting wherein they differ from the mature animal. Strive to learn to distinguish those things about a young animal which may indicate the possible manner of future development.

8. After studying the breeds with which you are acquainted, make a study of the different breeds of live stock. This is a long task, the work of a life time, and should not be attempted very largely until you have made a very close study and have become a good judge of some one breed. A study of the history of the origin and development of breeds, together with the lives of some of the men who have made marked improvement in live stock breeding, is interesting, and will be of help in understanding why it is that the breeds differ in form, habits, nature, etc. On page 126 is a list of books among which are some that will give you more information about these breeds.

COMPARATIVE JUDGING

Definition.—After a thorough study of the score card, and practice in comparing the points of a great many individual animals with the ideal described in the score card, you will be ready to start comparative judging. Instead of merely balancing the parts

of one animal against the description in the score card, compare the parts of several animals of the same kind, class, and age, keeping in mind the standard which they should approach.

Compare Points.—Make this comparison part by part, and record in your mind, or on paper, the parts in which each animal excels. For example: compare the *general appearance* of the animals in the class, and decide upon just what parts in general appearance each animal is better than the others. In beginning this work it will be well to write these points down, together with the ways in which they excel. In this same manner, consider all the parts in systematic order, listing points of merit or demerit, and stating just how the part is strong or weak. For further instruction in this, see the write-up of comparative judging in Parts II, III, IV, V, and VI of this circular.

Balance the Comparisons.—The best balanced animal, most uniformly perfect in the largest number of the most important points and without disqualifying weakness, should be placed first in the class. Your reasons for placing any animal ahead of any others should be so definite and clearly fixed in mind, that you can write a comparison of the several animals justifying your decisions. In writing this comparison, do not try to describe each animal, but tell wherein each is superior or inferior to the others.

Order of the Animals in the Ring.—When the animals are brought before the judge they are not in any regular specified order that is, as to their respective merits. The superintendent in charge of the judging should see that they are placed in an orderly way to avoid crowding and to admit of ready, careful inspection by the judge.

Cattle, sheep, and horses should be lined up on a level piece of ground, all facing the same direction and each held by an attendant. Hogs are not easily held, and they are best managed with a movable gate-like device called a 'hurdle.' Strange hogs, especially aged boars, should not be allowed to get together in the ring, as they will fight, and not only hurt each other, but cause a disturbance that will interfere with the work of properly judging them. In some instances they have been known to injure the judge.

For purposes of examination or comparison the judge may direct the animals to be moved about as he wishes, and placed in whatever order he desires. It is customary to have the animals finally placed in the order of their merit, the best one at the head of the class, the left end of the line, the second best next, and so on.

PART II

JUDGING HORSES

D. O. Thompson, Animal Husbandry Extension

INTRODUCTION

In order to intelligently study the score card, together with the descriptions given in it, it is necessary to learn the names of the parts of the horse. These accompany the picture of the draft gelding on which the parts are located by numbers.

Classification.—For the purpose of study, a broad classification may be made as follows: *market* horses; *breeding* horses. *Market* horses may be divided into four groups according to type, and the work that the horses are best fitted to perform, as follows: *draft horses,* horses principally valuable for moving heavy loads; *harness horses,* horses used for stylish driving, road work and racing in harness; *saddle horses,* horses used for riding purposes; and *ponies. Breeding* horses may be of any of the above types, and may be considered under two groups—*stallions* and *mares.*

DRAFT HORSES

The draft horse finds his particular field of usefulness in hauling heavy loads. He is a machine, the function of which is propulsion. In the score card below is given the description of the horse best fitted to do this. To best perform this work he must be heavily and strongly made. Everything about him should be massive.

SCORE CARD

DRAFT HORSES — MARKET

SCALE OF POINTS	Standard	Points deficient: Student's score	Points deficient: Corrected
GENERAL APPEARANCE—19 per cent.			
1. Height, estimated.....hands; actual.....hands.....			
2. Weight, over 1600 lbs.. estimated.....lbs. actual.....lbs., according to age.....	6		
3. Form, broad, massive, well proportioned, blocky, symmetrical	4		
4. Quality, refined; bone clean, hard, large, strong; tendons clean, defined; skin and hair fine; feather, if present, silky	6		
5. Temperament, energetic; disposition good	3		
HEAD AND NECK—9 per cent.			
6. Head, lean, proportionate size; profile straight	1		
7. Ears, medium size, well carried, alert	1		
8. Forehead, broad, full	1		
9. Eyes, full, bright, clear, same color	2		
10. Lower jaw, angles wide, clean	1		
11. Muzzle, neat; nostrils large, open, free from discharge; lips thin, even, firm	1		
12. Neck, well muscled, arched; throatlatch clean; windpipe large	2		

SCORE CARD (continued)

DRAFT HORSES — MARKET

SCALE OF POINTS	Standard	Points deficient: Student's score	Points deficient: Corrected
FOREQUARTERS—24 per cent.			
13. **Shoulders**, moderately sloping, smooth, snug, extending into back	3		
14. **Arm**, short, strongly muscled, thrown back, well set	1		
15. **Forearm**, strongly muscled, wide, clean	2		
16. **Knees**, deep, straight, wide, strongly supported	2		
17. **Cannons**, short, wide, clean; tendons defined, set back	2		
18. **Fetlocks**, wide, straight, strong, clean	1		
19. **Pasterns**, moderate length, sloping, strong, clean	2		
20. **Feet**, large, even size, sound; horn dense, waxy; sole concave; bars strong; frog large, elastic; heel wide and one-fourth to one-half the lineal length of toe	8		
21. **Legs**, viewed in front, a perpendicular line from the point of the shoulder should fall upon the center of the knee, cannon, pastern and foot. From the side, a perpendicular line dropping from the center of the elbow joint should fall upon the center of the knee and pastern joints and back of the hoof	3		
BODY—9 per cent.			
22. **Chest**, deep, wide, large girth	2		
23. **Ribs**, long, well sprung, close; coupling strong	2		
24. **Back**, straight, broad, strongly muscled	2		
25. **Loins**, wide, short, thickly muscled	2		
26. **Underline**, low; flanks full	1		
HINDQUARTERS—30 per cent.			
27. **Hips**, broad, smooth, level, well muscled	2		
28. **Croup**, not markedly drooping, wide, heavily muscled	2		
29. **Tail**, stylishly set and carried	1		
30. **Quarters**, deep, broad, heavily muscled, thighs strong	3		
31. **Gaskins**, long, wide, heavily muscled	2		
32. **Hocks**, large, clean, strong, wide, well set	6		
33. **Cannons**, short, wide, clean; tendons defined	2		
34. **Fetlocks**, wide, straight, strong, clean	1		
35. **Pasterns**, moderately sloping, strong, clean	2		
36. **Feet**, large, even size, sound; horn dense, waxy; sole concave; bars strong; frog large, elastic; heel wide, and one-fourth to one-half the lineal length of the toe	6		
37. **Legs**, viewed from behind, a perpendicular line from the point of the buttock should fall upon the center of the hock, cannon, pastern and foot. From side, a perpendicular line from the hip joint should fall upon the center of the foot and divide the gaskin in the middle, and a perpendicular line from the point of the buttock should run parallel with the line of the cannon	3		
ACTION—9 per cent.			
38. **Walk**, fast, elastic, regular, straight	6		
39. **Trot**, free, springy, balanced, straight	3		
Total	100		

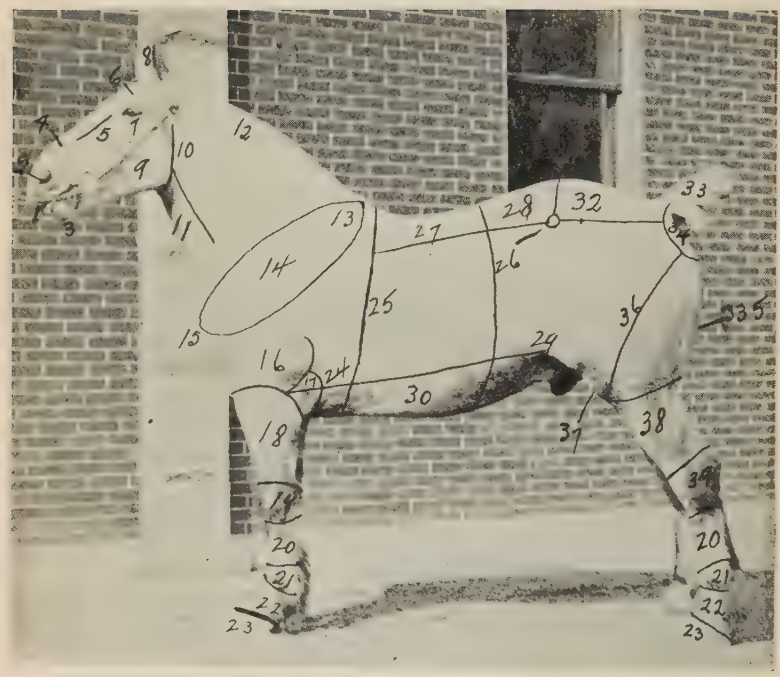


Fig. 3. Points of the horse

1. Mouth
2. Nostril
3. Chin
4. Nose
5. Face
6. Forehead
7. Eye
8. Ear
9. Lower jaw
10. Throatlatch
11. Windpipe
12. Crest
13. Withers
14. Shoulder
15. Breast
16. Arm
17. Elbow
18. Forearm
19. Knee
20. Cannon
21. Fetlock joint
22. Pastern
23. Foot
24. Fore flank
25. Heart girth
26. Coupling
27. Back
28. Loin
29. Rear flank
30. Belly
31. Hip
32. Croup
33. Tail
34. Buttocks
35. Quarters
36. Thigh
37. Stifle
38. Gaskin, or lower thigh
39. Hock

HEIGHT.—A "hand", the unit for measuring the height of the horse, is four inches. A measuring staff marked off in hands, inches, and fractional parts thereof, is used where the accurate height is required. Where such is not available, or where absolute accuracy is not demanded, a good way to estimate the horse's height is to 'chin' him. Find out how high it is from the ground to the point of your chin when standing erect. The measurement for the height of the horse is taken at the withers, indicated in the picture.



Fig. 4. Correct position for estimating height. Left hand shows point from which to measure

Stand facing the horse close to his side, on a level with the soles of his feet. Estimate how much the top of the withers varies in height from the point of your chin. For example: if from the ground to the point of your chin is 62 inches, or 15 hands, two inches, and the point of the withers is three inches higher, addition gives 65 inches, or 16 hands, one inch, as the height of the horse. The desired height for the draft horse is from 16 to 17 hands; a wide variation, however, from 16 to 18 hands, is common. The height should be due to depth of body instead of length of leg. A deep body indicates constitution, and capacity for food, which in turn indicate capacity for work.

WEIGHT—6 PER CENT.—The draft horse must weigh 1600 pounds, and should weigh a ton or over. This great weight should be largely due to massiveness of form and heavy frame and muscles, rather than to an excessive amount of fat. Weight holds the horse to the ground, enabling him to secure a foothold against which to exert his strength and throw his weight. Weight thrown forward is power in itself and the greater the weight to throw forward, the greater the power derived from it. The horse market classes horses weighing less than 1600 pounds, and of draft type, as *chunks* and *wagon* horses. Any horse under weight should not be allowed a

place in the draft classes in the show ring. Depth and width of body, compactness, blockiness, massiveness, heavy muscles, are some of the things which indicate great weight. Excessive fat should not be considered a credit. Long legs, light bone and muscles, long body with small girth at the heart and flank, and long coupling, are some of the things which indicate that the horse is not heavy for his height, and should cause you to discriminate against him in the show ring, and cut him heavily when scoring.



Fig. 5. Muscular, compact, low set, draft conformation. "Prince." International champion draft gelding, 1910

FORM—4 PER CENT.—Stand at a convenient distance in front of the horse, facing him, and note the form of the head, the balance of its parts, the width of breast and depth of chest, strength and straightness of the fore legs. You should see a large, clean-cut head, bright eyes, large, open nostrils, proportionate muzzle, broad forehead; a large windpipe; great breadth between the points of the shoulder; a wide breast and floor of the chest; a pair of short, strong clean, heavily muscled legs supporting the shoulders, squarely placed and vertical to the ground. A narrow forehead means small brain and nerve development, a tendency for the horse to be slow

going and unintelligent. Small, contracted nostrils and windpipe are generally associated with a narrow chest and small heart girth, indicating weak constitution and limited endurance.

Observing the horse from the side, note the upper and lower lines, the balance of the fore and hind quarters, the depth of body, the straightness and muscles of back, compactness and closeness to the ground. The body should be deep and well proportioned in all its parts, giving a well balanced appearance. The fore and hind flanks should be low, the back and loin straight, strong, short, and heavily muscled. The coupling should be close and strong. The compactness and squareness of the body should be completed by the croup carrying out level to the tail-head. A sagging, 'hollow' back, long, 'washy' coupling, steep croup, cut-up flank, long, poorly placed legs, are some of the most frequent faults to be seen from the side view.

Passing to a safe distance at the rear of the horse, note the width and straightness of croup, the muscles of the thighs and quarters, and the position of the hind legs. The croup should be wide and straight; quarters and thighs, deep and heavily muscled; the legs straight and squarely placed under the body. Narrow or lightly muscled croup, quarters, or thighs, or crooked legs are serious faults. After a view from the other side you will have finished the examination for form.

Lack of depth of body, too much ranginess, openness, legginess, lightness of muscling and of body are some of the things to be most severely criticised. These deficiencies of form detract from the weight and strength, and therefore from the pulling power of the horse.

Quality—6 per cent.—From the same position as before, note the flatness and cleanness of cannon, cleanness and definition of the joints, fineness of coat, mane and tail, cleanness of head. There is a correlation of the external and the internal anatomy of the animal; therefore, these may be taken as indications of quality. High quality is shown by a flat appearing, clean cannon bone; hard, clean and well defined joints; fine skin, hair, mane, and tail; clean cut and sharply defined features of the head, thin, even lips, and fine ears. All of this fineness should be accompanied by sufficient substance; that is, a small cannon bone is not necessarily a bone of high quality; neither is a large cannon bone necessarily one of poor quality. A cannon bone behind which the tendon is clean and clearly defined, giving a flat appearance to the cannon indicates wearing quality; fineness of hair about the leg and hoofhead, or coronet, indicates that the small fibres of the wall of the hoof and the structure of the bone are fine, making a dense hoof wall and a hard, clean

sound bone. The value of the horse, the length of time he will be of service, depends largely upon the quality of all his parts. Superior quality increases the selling price of the draft horse. [1]The common, sound, 1800 pound drafter sells at $300 on the Chicago market; give him style and quality and he will sell on the same market at $450. Heavy horses of very low quality, sell on the horse market as loggers, and for a lower price than the drafter of good quality, suitable for city service.

TEMPERAMENT—3 PER CENT.—A live, snappy, energetic temperament, together with a docile, manageable disposition, should entitle a horse to a full score, and should give him preference over a horse with either a vicious disposition, or a slow, sluggish, lazy temperament.

HEAD AND NECK—9 PER CENT.—The head and neck should be of such excellence of feature, form and quality, that they give the horse a distinctively pleasing, stylish appearance, either in or



Fig. 6. A "Good Outlook." Head should be clean cut, neck muscular, arched, and long enough to give a pleasing appearance in harness

out of harness. Some of the most common faults to expect are, a coarse, meaty, over or under-sized head, with a "Roman nose;" a narrow, dished or bulging forehead; blindness or defective eyes; large, meanly carried, poorly attached ears; weak, narrow jaw, meaty in the angles; small muzzle; poorly controlled lips; teeth not meeting evenly, making a 'parrot' mouth, or an 'undershot' jaw; a poorly muscled, 'ewe' neck, with a coarse, meaty throatlatch, and a small contracted windpipe. Any of the above faults detract from the appearance of the horse and decrease his usefulness and selling price.

FOREQUARTERS—24 PER CENT.—The *shoulder* should be smooth and strong. It should form a collar bed against which the pulling

[1] T. W. Bell, Union Stock Yards Horse Exchange, Chicago

power of the horse may be applied for a long time without sores and unsoundness developing. The rough, angular shoulder is more liable to become sore and unsound than the smooth, snug shoulder. *The slope of the shoulder*, that is, the direction of a line which you might draw from the top of the withers to the point of the shoulder, is closely related to the slope of the pastern joint. Upright shoulders and pasterns mean a short, stubby, wearing, undesirable way of going. Too great slope of these two parts means a poorly controlled, ambling way of going. A slope of about 45 degrees is proper. The *arm,* lying between the point of the shoulder and the elbow joint, should be short and heavily muscled, strongly supporting the shoulder. It should lie in a nearly horizontal plane, well thrown back under the body, insuring strength and desirable action. Weak musculing and upright position are common faults. Heavy muscles on the upper part of the *forearm,* and a clean, 'cordy,' flat appearance of the lower part, indicate strength. Here is a good place to estimate the probable size of the hidden muscles of the horse. The appearance of strength of the back and loin may be improved by fat, but the forearm does not fatten. Its size depends upon the muscular tissue present. Light muscles of the forearm are taken to indicate light muscles, therefore weakness, throughout the horse. The *knee joints* should be large, straight, and angular (not round or egg shaped as viewed from in front), with the tendon standing out well behind, giving strength and support to the joint. A tied-in appearance below and at the back of the knee indicates weakness. The *cannons* should be short, clean, with the tendon well defined at the back, giving the leg a flat appearance. Shortness increases power and improves action. Roundness, coarseness, or too much fineness (lack of substance) are undesirable. The *fetlock joints* should be clean, straight, and strong. The *pasterns,* viewed from the side, should show a slope of about 45 degrees, and will have about the same slope as the shoulder. This slope allows of some spring and elasticity in this part when the foot meets the ground. Pasterns too upright give the horse a stubby, pounding way of going, tending to produce foot troubles and unsoundness, as sidebones, ringbones, navicular disease and stiffness. Pasterns with too great a slope are weak and liable to break down when the horse becomes old, or is put under a great strain for a long time.

The *foot* should be attached to the leg so that it toes straight ahead rather than in or out. This position permits straight, forward action. If the toes turn in, the horse throws his feet out when bringing them forward, or 'wings.' If the toes turn out, the horse throws his feet in when bringing them forward, or 'paddles.' Either fault tends to unbalance the stride, decrease its length, and causes

the foot or the shoe to wear unevenly. View the shape and size of the fore feet from in front and from the side. The feet should be large, even in size, and from the front view should appear nearly circular at the line of contact with the ground, the circle making a somewhat abrupt turn at the inside front arc, and following a trifle less circular line to the inside quarter. From the side, note the slope of toe and of the heel and their proportionate lengths. The length of the heel should equal one-fourth to one-half the lineal length of the toe. The heel should be parallel to the median line of the foot, and should appear parallel to the toe when viewed in profile. The toe should slope at an angle of about 50 degrees, and should harmonize in this respect with the slope of the shoulder and of the pastern, which as above stated should be about 45 degrees. The hoof wall should be free from cracks or breaks. Lift the foot, and hold it by the point of the toe with the sole upturned. The heel should be wide throughout its length, widening somewhat as it reaches the sole of the foot. The frog, that spongy portion beneath the heel, should be well defined, large, and elastic to the touch. Hardness, dryness, decaying conditions, and total absence of frog, are serious faults. The bars are horny braces leading from the point of the frog to the hoof wall at the sides of the heel on both sides of the frog. Their purpose is to keep the heel from contracting, and they should appear strong and well defined. If the blacksmith has cut them out, or for some other reason they are not strong, the heel will be contracted, crowding the frog out of shape and place. The dense sole of the foot should be very slightly concave. The arched or concave sole gives a stronger support to the interior anatomy of the foot than would a flat or a convex sole. As soon as his feet wear out or become notably unsound, the horse is no longer serviceable on the city streets. Any faults about the feet should cause severe criticism of the horse and discrimination against him in the show or sales ring.

Body—9 per cent.—From a position at the side of the horse, observe the form of the body. The fore rib should be well sprung and long, giving the horse a broad back and a deep chest. The back and loin should be short and heavily muscled, the coupling should be close and strong, the rib roundly arched, the flank low, giving the horse a deep, strong-bodied appearance, abundance of room for the respiratory and digestive organs, and the ability to endure strenuous labor for a long period of time. Do not mistake excessive fat over the back and loin for heavy muscling. A horse with a shallow body, poor spring of ribs, hollow or weakly muscled back and loin, and with long, open coupling is neither a good, hardy worker nor an "easy keeper."

HINDQUARTERS—30 PER CENT.—Exercise caution in making an examination of the hindquarters of a horse. Make observations from a safe distance at the rear or the side, and when necessary to handle a part to aid the eye in determining quality, size, condition or soundness, never approach the horse from the rear, nor without first speaking to him, thus warning him of your approach. Speak to him, and then, making your approach from the side, lay your hand on his back, following along the loin, thigh, and gaskin, and thence to the region you desire to examine. Always expect a kick and maintain a position at all times from which you can readily escape injury. A squatting position, or one at the immediate rear of the horse should never be assumed, as they are unnecessary, undignified, and dangerous. From the side and rear observe the distance between, and the smoothness of the hips, the width and levelness of the croup, the depth and fullness of the quarters, and thighs, and the strength of the gaskins. Note the muscling throughout. The hips should be proportionate in width to the general width of



Fig. 7. Weak, sickle-shaped hocks



Fig. 8. Straight, upright pasterns, showing cocked ankle

These faulty conformations are often transmitted from stallions and mares to the offspring. Legs built like these are weak and subject to unsoundness

the body. Prominent, rough hips are unsightly and more susceptible to injury than smoothly covered hips. To afford room for heavy muscling, and to improve the general appearance of the horse, the croup should be level, wide, and fairly long. A short, steep croup is a common fault. Deep, strongly muscled quarters and thighs are required for strength. The gaskin, or lower thigh, should be short and heavily muscled, indicating great development of muscle throughout the body. This whole region of the horse should be powerfully built and heavily muscled, for most of the force in pulling is exerted by the muscles of the hindquarters.

You can best note the shape, strength, and soundness of the hock from a position in line with the head of the horse, and to either side. From this position you see the face of the hock which should be broad, clean, flat, and strongly supported below. The juncture of the hock with the cannon bone should be strong, and should not appear cut-in. Passing again toward the rear and continuing the examination, note the back and sides of the joint, which should be long from top to bottom, angular, strong, sharply defined and strongly supported by the back tendon. Soft, full, puffy, small, rounded, or crooked hocks deserve a considerable cut on the score card or in case of comparative work, should cause the horse so afflicted to be strongly discriminated against. With the exception that the hind cannons are usually wider, pasterns and toes slightly shorter and more nearly upright, an angle of about 50 degrees for the former, and 60 degrees for the latter and the feet less rounding, the requirements are the same as forward, and may be seen from about the same relative positions. The common faults are about the same as in front. The set of the fore and hind legs when the horse stands naturally and is not posed should be as described in the score card, and with a little work you will become able to recognize correct and faulty position of the legs. Most of the faults in the way the horse goes are due to a faulty attitude of either the fore or the hind legs, or both; hence the necessity of having a faultless set of legs.

Comparative Judging.—The work thus far has been planned to create within your mind an ideal of a draft horse. The standard of perfection, the method of examination, and many of the common faults, have been presented. The aim has been to teach you to see the horse in detail, and seeing, to recognize merits and faults, together with their relative importance.

JUDGING ACTION—THE WALK[1]



Fig. 9. Have the horse moved away from you at the walk. His feet should be lifted with a snap, the joints flexed so that the shoe shows plainly, and carried forward in a straight line. The hocks should not be carried wide, nor close together, either position being a bad fault, the former of far more frequent occurrence



Fig. 10. Have the horse brought back toward you at the walk. His feet should be lifted clear of the ground, brought forward straight, and meet the ground so that no dirt or dust is kicked forward by the impact. This means that the heel meets the ground ahead of the toe, and that the horse does not have an undesirable, stubby gait

[1]Position of man with whip in Figs. 9, 10, 11, 12, indicates position from which to judge action

JUDGING ACTION—THE TROT



Fig. 11. Have the horse moved away from you at the trot. His feet should be lifted with a snap, the shoe showing plainly, and there should be no spraddling, due to going too wide, nor interfering, due to going too close. There should be no roll to the body due to poor position of the legs or poor flexion of the joints



Fig. 12. Have the horse brought back toward you at the trot. His feet should be lifted clear of the ground, brought straight forward, without throwing the fore feet either out or in, called "winging" or "paddling", and should meet the ground heel first, as will be shown by the fact that no dirt is stubbed up by the impact. A stubby gait is undesirable. A rolling gait, due to the legs being placed too wide on the body, is faulty

JUDGING ACTION



Fig. 13. Have the horse moved past you at the walk. He should move with a quick, energetic, lengthy stride that carries him straight forward. Note the length of stride, the flexion of the joints, and whether or not the ground is well cleared without any useless expenditure of energy or shortening of the stride by high going action



Fig. 14. Have the horse moved past you at the trot. He should flex the joints enough so that there is no chance of stumbling, carry the feet straight forward in a long, even stride. At the end of the stride, the feet should meet the ground heel first, thus allowing of a better spring in the pastern joint, and doing away with the stubby action generally associated with upright pasterns

Henceforth, instead of comparing the horse with a standard of perfection, you will compare two or several horses. The question arising for answer will be, "In what ways affecting his utility, or market value, is each horse superior or inferior to all others with which he is being compared?" To answer this, it will be necessary to merge to a considerable degree the many details of the horse described in the score card, and consider those more inclusive characters or qualities about the horse, affecting his utility or market value: as *size, soundness, conformation, quality, action, temperament* and *style.*

Note and compare relative sizes, heights, weights, and general conformations of the horses in a class of several, to be placed in the order of their merit. Specific parts in conformation to be given especial attention are body, shoulders and pasterns, hocks and feet. Make examination for soundness while comparing quality. While the horses are being moved to permit of judging action, note and compare their temperament and style.

The horse superior in the greatest number of these primary considerations and without notable fault in other important respects, will be of the greatest service and will sell for the highest price on the market, therefore is the most desirable. If he be notably inferior in any of the above respects, his selling price will be lessened and his utility value diminished.

HARNESS HORSES

After becoming familiar with the points of the horse, and having made a careful study of the draft horse, it will be an easier matter to learn to judge the other classes of horses. All the parts are named the same; indications of quality, constitution, etc.; methods of making observations and examinations are the same. Differences which fit horses for particular kinds of work cause them to be classified differently.

In the draft horse the essential requirement is pulling power; in the heavy harness horse, style, action, and conformation; in the light harness horse, speed and endurance; saddle horses, gaits, style, temperament, and carrying strength; ponies, style and tractable disposition.

Harness horses are generally divided into two classes, the *heavy* and the *light.* The heavy harness class includes horses of the coach type, which are driven at a slow trot or walk to a heavy vehicle. The light harness class is made up of horses of the roadster type, which are driven to a lighter, plainer vehicle, at a faster, less stylish gait, or are used for racing.

Heavy Harness Horses

General Description.—The heavy harness horse is fairly compact, smoothly turned, and has a high, flashy, trappy action. It ranges from 15 to 16 hands in height, and from 1100 pounds to 1400 pounds in weight.

Form.—The head and neck should be clean cut, attractive, and high and gracefully carried. The shoulders and pasterns must be



Fig. 15. Strength



Fig. 16. Speed

The broad muscular breast, heavy muscles of the arm and fore arm, well supported, large knees, short cannons, strong fetlocks and pasterns, and large sound feet, all indicate pulling power. The deep chest, long, lithe muscles, clean joints and cannons, long cannons, and pasterns and tough feet, indicate speed and endurance

oblique and the knees and feet strong and perfectly free from any unsoundness or weakness of conformation. The back should be short and straight; ribs roundly sprung and deep; coupling, strong and close; croup long and level and the tail set high. The quarters and gaskins should be thickly muscled; hocks clean and large; feet of medium size. The legs should be straight, and perfectly placed under the body.

Quality.—The heavy harness horse must be of superb quality in order that it may have that general air of finish and refinement which is an absolute essential to this class of horses, in which style is of the greatest importance.

Action.—This is one of the most essential qualities of the harness horse. All movements must be graceful and in perfect balance. If the horse can not move with plenty of smoothness, flash, and style, he is among the 'undesirables.' The fore feet must be carried straight and high; the knee folding and carrying the foot forward in a graceful curve. The hocks must be sharply flexed and the feet kept well under the body. The action of this class differs from that of the roadster, in that the stride is not as long, feet are carried higher, with more snap, and are kept more nearly under the body at all times.



Fig. 17. Heavy harness horse. Note the refinement of head, length of neck, slope of shoulder and pasterns, compactness of body. Champion Hackney stallion, 1908 Royal Show, England

Light Harness Horses

General Description.—The light harness horse is more rangy and angular, with lighter and longer muscles than any of the other types. Its purpose is to move a light vehicle at a rapid rate of speed for a greater or less period of time, endurance in either case

being necessary. The roadster must have stamina, or 'bottom,' spring-steel quality, courage, and grit, perfect constitution and good sense or level headedness.

The most desirable height and size is 15 hands, three inches, and 1100 pounds respectively. The range on the market is from 15 to 16 hands in height and from 900 to 1150 pounds in weight.

Form.—The head should be medium in size, with clean-cut features, full, bold eye, erect, medium-sized ears, and large, open nostrils. The throatlatch should be clean cut, the neck long and slightly arched. A sloping shoulder should extend well into the back.

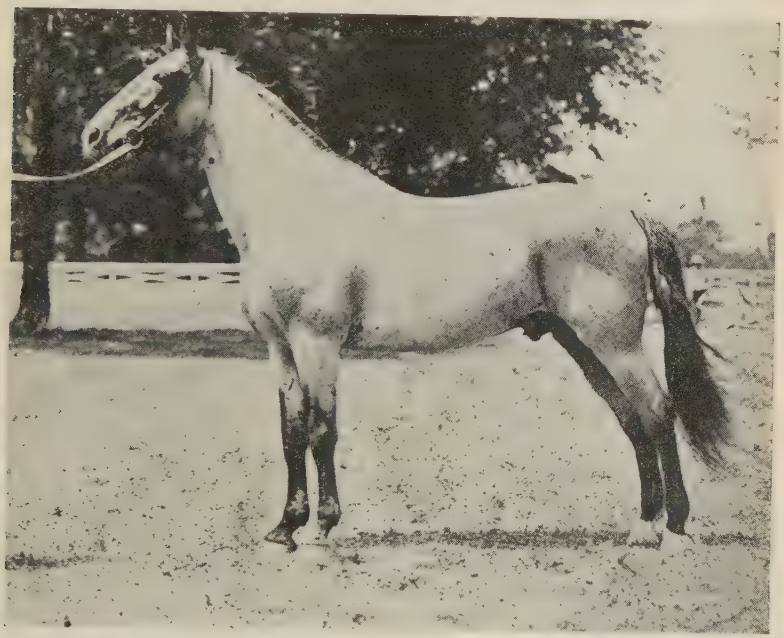


Fig. 18. Light harness horse. Angularity and length of body and limbs indicate speed. Depth of chest and quality of legs and feet indicate stamina and endurance. Standard-bred stallion

Strong, long muscles should cover the arm and forearm. The knees should be strongly supported, cannons flat, and the pasterns long, and obliquely set, with the feet strong, and of medium size. The body should be deep, closely ribbed, and strongly coupled; the croup level and nicely rounded with muscles. The muscles of the thighs, quarters, and gaskins should be long and heavy. The hocks must be large, clean-cut, angular, and strongly supported.

Action.—The action of the roadster should be moderately high, and the stride long and frictionless. The feet must be carried straight forward and extend farther behind and reach farther in front than with either the heavy harness or the saddle horse. Forging, cross-firing, interfering, paddling and winging, and going too wide behind, are some of the common faults.



Fig. 19. Quality, style, and spirit; light harness type. Three year old, standard-bred filly

SADDLE HORSES

General Description.—In the United States there are two classes of saddle horses; the *five-gaited* and the *three-gaited,* or *walk-trot-canter saddle horse.* The size and weight of this class varies according to the weight to be carried. The classification on the market gives a range from 14.3 to 16 hands in height, and from 900 to 1200 pounds in weight.

Form.—The two types differ but little in conformation, the five-gaited type being less rangy, having more graceful lines, and presenting a smoother, rounder appearance than the three-gaited type. The quality, set of legs, and conformation in general are slightly similar to that of the carriage horse, a slightly greater emphasis being placed upon the length of neck, slope of shoulder, height of withers, and length and slope of pasterns, than in any other class, insuring comfort and endurance to rider and horse.

Action.—The three-gaited horse should go plain walk briskly and with speed equal to four miles an hour; canter reasonably high

and gentle; trot steady, straight, and true; action enough to be attractive; well balanced and with speed equal to 12 miles an hour.

Added to the foregoing, the five-gaited horse should go running walk, fox trot, or slow pace smoothly and equal to six miles an hour; rack easily without being forced, with speed equal to 12 miles an hour. Must stand quietly, back readily, and lead with either foot in a canter from a halt. (Not required or desired to change lead in action.)

In showing, high rate of speed and racing are forbidden, and any 'High School' will be accepted as a disqualification.

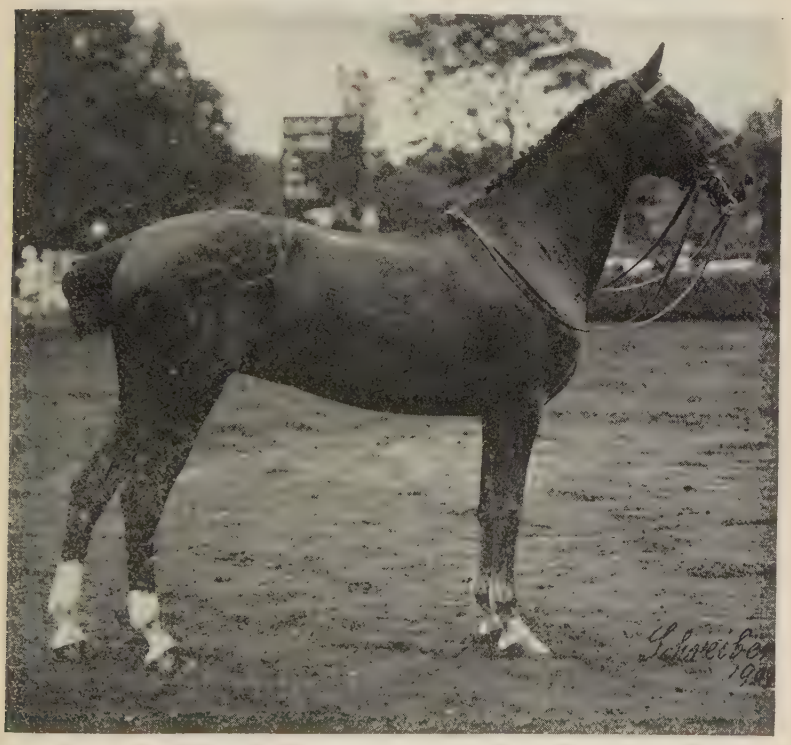


Fig. 20. Popular type of saddle mare. Length of neck, height of withers, strength of back, levelness of croup, length and attitude of the legs are typical of the saddle horse. "Sonia." Champion Philadelphia Horse Show, 1909

PONIES

The market does not attempt to specify weight limits for ponies. Fourteen hands is given as the maximum height. In the three more prominent breeds of ponies—Shetland, Welch, and Hackney, the maximum heights are respectively: 46 inches; 13 hands; and 14 hands.

The conformation of ponies varies greatly, some being like small carriage horses, while others, especially Shetlands, are often blocky and compact, representing miniature draft horses in form. The more rangy type is rather more in favor. Temperament is of utmost importance. The pony should show considerable energy and snap, but must be docile and easily tractable so that he may be perfectly safe for children's use. The more attractive the action, other things being equal, the more desirable the pony.



Photo by Hildebrand

Fig. 21. Type of Shetland pony in high demand. Dam and three of her produce. Uniformity of produce illustrates prepotency of dam

BREEDING CLASSES

In judging stallions or mares of any of the foregoing classes of horses, base your decisions to a great extent on excellence in sex characters, adherence to breed type, and degree of soundness.

Sex Characters.—The stallion should be a virile male. His entire bearing should be masculine. Bold, flashing eyes, haughty carriage of the head, heavy development of crest and forequarters should mark him as pre-eminently masculine. These indicate great breeding powers, and strong prepotency. His conformation and disposition should be in direct contrast to that of the mare.

The hindquarters of the mare should be wide and roomy, indicating ability to exercise the maternal functions. The back and underline should be longer than in the stallion. She should have

a deep chest and body indicating strength of constitution. Her forequarters, neck, and head, should be refined, combined with a quiet disposition, to give her a feminine appearance throughout.

Breed Characters.—Certain breeds have been developed to do certain kinds of work. Size, conformation, quality, action, those essentials to the proper performance of that work, should be of first consideration in judging breeding classes. Color, shape of



Fig. 22. Draft mare. Correct size, type, and quality for raising heavy draft horses for the market. A money maker where intelligently managed. Pure-bred Percheron

head, prominence of eye, slope of shoulder or pastern, slope of the croup, blockiness, quality and size of feet, presence or absence of hair on the legs ("feather"), are breed characters, adherence to which indicates purity of breeding. Therefore, in judging breeding classes of horses, these secondary breed characters must be given due consideration. A detailed study of the breeds will aid in learning the characters of the different breeds of horses.

Predisposition to Unsoundness Transmitted to Offspring. —Predisposition[1] to certain unsoundnesses is considered by the best authorities to be hereditary. Weak conformations in which unsoundnesses sooner or later develop are transmitted with marked regularity from sire and dam to the offspring. Dr. Alexander[2] gives the following as unsoundnesses and faulty conformations which should disqualify either stallion or mare from being used for breeding purposes: *moonblindness; blue eye; cataract; heaves; broken wind; spavins; ringbones; sidebones; navicular disease*



Fig. 23. The farm mare. Brood mares of draft type, weighing about 1600 pounds in working condition, should be in service on the farms of Indiana

(grogginess); hocks, sickle formed, curby, crooked, boggy, sprung; hoofs, flat, weak, unsound; "washy" couplings; pasterns, short, upright.

It is not the purpose here to discuss at length the numerous unsoundnesses to which the horse is heir. The location and names of the more common unsoundnesses listed in systematic order will aid in examining for soundness. Column 1 gives the place to look; column 2 some of the unsoundnesses to expect. Unsoundness in any part makes the horse "unsound" on the market. The Chicago Horse Market has discontinued the use of the term "serviceably sound," as it left too great an opportunity for controversy. Horses are now sold as sound or unsound.

[1] An inborn liability or tendency
[2] University of Wisconsin, Madison, Wis.

Location of Common Unsoundnesses and Faults

Where to Look	What to Look For
1. Head	1. Poll evil
2. Eyes	1. Blindness 2. "Blue-eyed"
3. Ears	1. Overmobile:—indicates a. Viciousness b. Blindness 2. Immobile:—indicates a. Deafness b. Lockjaw
4. Muzzle	1. Discharge:—indicates a. Catarrh b. Glanders c. Diseased molars 2. Signs of roaring 3. Bit sores
5. Teeth	1. Diseased molars 2. "Bishopped"—cut to appear young 3. "Parrot" mouth 4. Undershot jaw
6. Tongue	1. Mutilation—end cut off to prevent lolling
7. Under jaw	1. Abscesses
8. Neck	1. Broken crest 2. Sores 3. Skin disease 4. Braided in mane
9. Withers	1. Fistula
10. Shoulders	1. Collar boils 2. Sweeney 3. Abscess or fistula
11. Elbow	1. Shoe boil
12. Knee	1. High splint 2. Broken knee 3. Buck knee 4. Calf knee 5. Capped knee
13. Cannons	1. Splints 2. Thick tendons 3. Grease heel 4. Scratches



Photo by Dr. R. A. Craig, Purdue

Fig. 24. Buck knees

Location of Common Unsoundnesses and Faults (continued)

Where to Look	What to Look For
14. Fetlocks	1. Windgalls 2. Interfering sores 3. Cocked ankles 4. Grease heel 5. Scratches 6. Scars of unnerving; to prevent lameness due to ringbone or navicular disease
15. Pasterns	1. Ringbones
16. Coronets	1. Sidebone 2. Quittor
17. Feet	1. Navicular disease; shown by contracted foot favored in action 2. Founder 3. Toe cracks 4. Quarter cracks 5. Corns 6. Thrush
18. Hips	1. Fractured ilium 2. Knocked-down hip
19. Tail	1. Unhealed docked end 2. False tail attached
20. Stifle	1. Knee-cap out of place 2. Dropsical swelling
21. Hocks	1. Spavins a. Bone b. Bog 2. Thoroughpin 3. Curb 4. Jarde
22. General	1. St. Vitus dance 2. Crampiness 3. Stringhalt 4. Roaring 5. Heaves
23. Vices	1. Cribbing 2. Wind sucking 3. Halter pulling 4. Balking 5. Biting 6. Rolling in stall 7. Kicking



Fig. 25. Poll evil

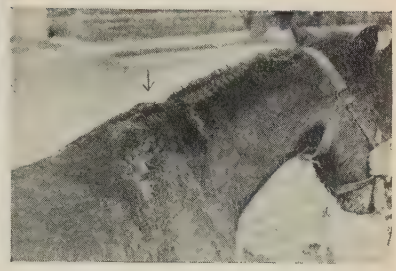


Fig. 26. Fistula of the withers





Photos by Craig

Fig. 27. Collar boil

Fig. 28. Shoe boil



Photo by Craig

Fig. 29. Right foot contracted due to navicular disease



Fig. 30. Ringbone



Fig. 31. Bone spavin



Photo by Craig

Fig. 32. Incomplete toe cracks





Photos by Craig

Fig. 33. Extreme case of quarter crack

Fig. 34. Knocked down hip

PART III

JUDGING BEEF CATTLE

F. G. King, Associate in Animal Husbandry

INTRODUCTION

Classification.—Beef cattle are divided into three general classes, depending on the purpose for which they are to be used—*butchering, feeding* or *breeding*. The ultimate end of all beef animals is the butcher's block and the one that comes nearest to meeting the ideal of the butcher is the one which the feeder and breeder must strive to produce. The stock feeder when selecting cattle for the feed or show yard must ever keep in mind the steer that will most nearly meet the demands of the butcher and at the same time be an economical producer. The breeder must keep in mind when selecting his breeding stock not only the good killing animal which the butcher demands and the quick fattening one desired by the feeder but also one that has in addition to the killing and feeding qualities, indications of being a good breeder as well. In other words the breeding animal must give evidence of the ability to transmit his or her own good qualities to the offspring.

FAT STEERS

What the Butcher Demands.—Since the butcher is the final judge of excellence in an animal and is largely responsible for the ideals of the feeder and the breeder, the animal that will most nearly meet his demands, is the one the latter classes of cattlemen must strive to produce. The steer that brings the highest price from the butcher is one that will dress the highest per cent. of salable meat and will also have a maximum amount of this meat located in the most valuable cuts, which requires that the animal have the best *conformation, quality,* and *condition.*

Conformation.—The form of animal that meets with most favor in the eyes of the butcher can most readily be seen by studying the following figures. Fig. 35 shows a side of beef divided into the wholesale cuts. The table gives the name, per cent. of the carcass by weight, value per pound on May 1, 1911, and the percentage of the total value of the carcass found in each of the various wholesale cuts of meat. Fig. 36 shows the location of the wholesale cuts of meat on the live animal.

A comparison of Figs. 35 and 36 shows that the head, and legs below the hocks and knees are not considered in the dressing of the

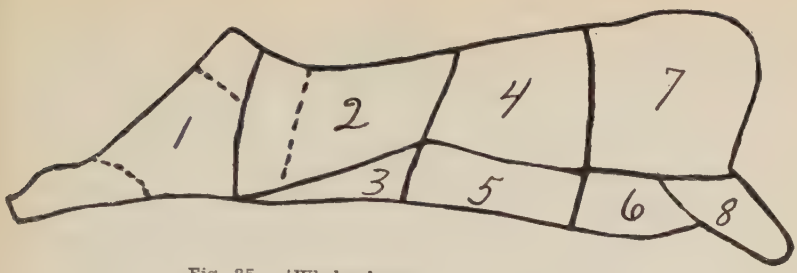


Fig. 35. [1]Wholesale cuts on the beef carcass

Wholesale Cuts of Beef

Name	Per cent. of carcass	Value per pound	Per cent. of value of carcass
1. Round	23	9.5 cts.	23.18
2. Loin	17	14.5 cts.	26.15
3. Flank	4	7 cts.	2.97
4. Rib	9	12 5 cts.	11.93
5–6. Plate	13	7 cts.	9.65
7. Chuck	26	7.7 cts.	21.24
8. Shank	4	5.5 cts.	2.33
9. Suet	4	6 cts.	2.55

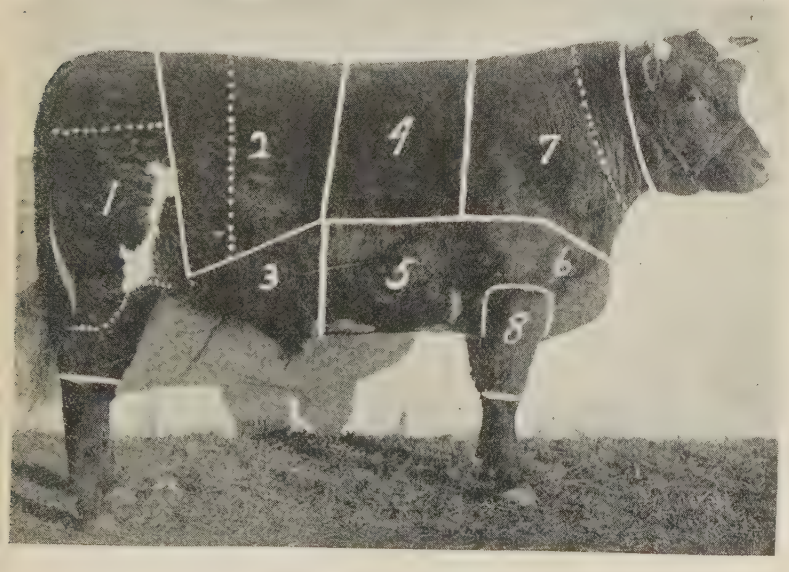


Fig. 36. Wholesale cuts located on live steer

[1]*Wholesale Cuts.* The division the packer makes of the carcass when he sells n large quantities to retailers or to large consumers, as hotels, railroads, etc.

animal. These parts are worth only a few cents and should be as small and refined as possible. The most valuable part of the carcass is the loin which extends from behind the hip joints, or hooks, forward to and including the last rib and while it constitutes only 17 per cent. of the weight of the carcass, its value is more than 26 per cent. of the entire beef. The next highest priced cut is the rib which extends from the loin forward to and including the sixth rib. It contains only nine per cent. by weight but is worth approximately 12 per cent. in value of the entire carcass. The round, which includes in wholesale cuts, the rump (marked by the upper dotted line) and the shank (separated by the lower dotted line) constitute the salable portion of the carcass found back of the loin. Including the rump and shank, the round is worth as much per pound as an average of the carcass but the portion between the dotted lines contains more meat and is valued approximately the same per pound as the ribs. The importance of having a broad backed, deep quartered steer is shown by the fact that while less than 40 per cent. of the weight of the carcass is found in the loin, ribs and round, more than 60 per cent. of the value of the entire animal is found in these three cuts. Hence, the steer that carries a thick, even covering of flesh in the region of these valuable cuts meets with the greatest favor among the killers and retailers of meat. The chuck is the next in rank as regards value per pound and lies in front of the ribs. The neck while included in the chuck is much poorer in quality than the other portions of the cut and should be as short as possible. The flank, plate, and shank which are found in the lower part of the body, are the lowest priced meat found on the carcass. The steer, therefore, with the greatest development in the upper half of the body and with the smallest amount of waste in the head, legs, hide, etc., not only gives the highest dressing per cent. but also the greatest proportion of high priced meat when the animal is dressed.

Quality.—The term "quality" in a fat steer is taken to mean not only the proper kind of bone, hair, skin, etc., which is demanded in thin as well as fat cattle and may be known as "general quality," but also smoothness and firmness of covering, or "quality of flesh". Under the former head would come the indications of having the greatest strength and substance in the least amount of space which are shown by clean bone, soft, mellow hide, fine, silky hair and general refinement of features, and a strikingly clear-cut appearance. Lack of quality is shown in a large, coarse head, heavy, open or rough shoulders, prominent hip bones, coarse joints and large, rough legs. Quality of flesh is denoted by having all parts of the body covered thickly and evenly with firm, mellow

flesh. Deficiencies in this regard are commonly found in cattle too thinly covered or having lumps or rolls of fat along the ribs, patches about the tail-head, bare places on the shoulder, uneven covering along the back, or soft, blubbery fat.

CONDITION.—In order to dress a high per cent. of meat, an animal must be in high condition, or finished. In other words, the fattening process must have continued until the fat cells have become filled with fat. This fattening process not only increases the dressing per cent. but also adds to the value of the meat, in that it is rendered more tender and palatable and can be stored with less

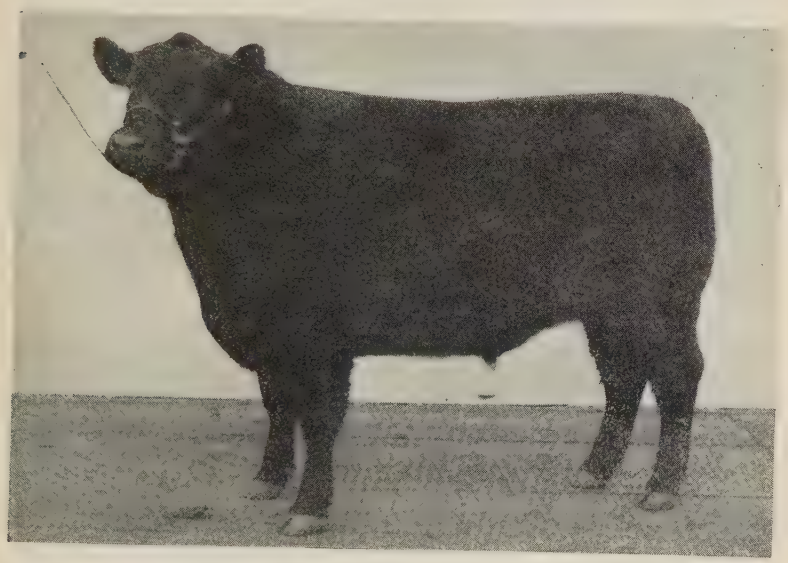


Photo by Hildebrand

Fig. 37. Thick, deep body; short head and neck. With exception of a slight lack of depth in hind flank and some extra length of leg, he represents almost an ideal fat steer. "Fyvie Knight." Grand champion fat steer, International Live Stock Exposition, 1908

danger of decay. One of the best ways of judging the finish of a steer is to press the hand against the flesh along the ribs and sides. When the flesh is firm and thick the animal is usually in condition for slaughter. Another method of telling whether the fattening process is finished is to feel the cod or purse which is one of the last places to fill with fat. When the cod is full and soft the steer is considered finished. A full flank is also another indication of ripeness. On a finished steer, the flank should be full, pendent and have the entire cavity filled until it is level with the bottom lines of the body.

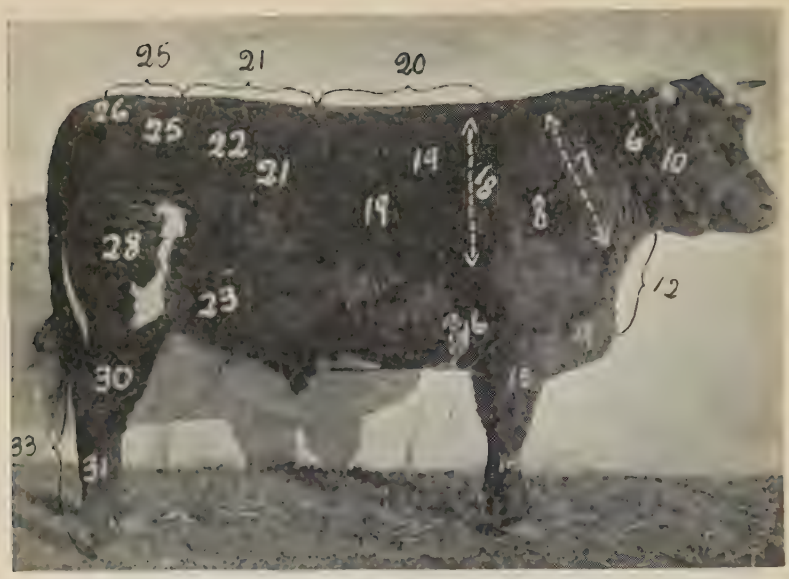


Fig. 38. Points of the beef animal



Fig. 39. Points of the beef animal



Fig. 40. Points of the beef animal

1. Muzzle
2. Eyes
3. Face
4. Forehead
5. Ears
6. Neck
7. Shoulder vein
8. Shoulders
9. Brisket
10. Jaw
11. Breast
12. Dewlap or heavy skin on neck
13. Arm
14. Shin
15. Legs
16. Chest
17. Fore flank
18. Crops
19. Ribs
20. Back
21. Loin
22. Hips or hooks
23. Hind flank
24. Purse or cod
25. Rump
26. Tail-head
27. Pin bones
28. Thigh
29. Twist
30. Hocks
31. Shanks
32. Tail

THE SCORE CARD

BEEF CATTLE **FAT**

SCALE OF POINTS	Standard	Points deficient	
		Student's score	Corrected
GENERAL APPEARANCE—40 per cent.			
1. **Weight,** estimated.....lbs. Actual.....lbs. according to age	10		
2. **Form,** straight top and underline: deep broad, low set, stylish, smooth, compact, symmetrical	10		
3. **Quality,** fine, soft hair; loose, pliable skin of medium thickness; dense, clean, medium-sized bone	8		
4. **Condition,** deep, even covering of firm mellow flesh; free from patches, ties, lumps, and rolls; full cod and flank indicating finish	12		
HEAD AND NECK—7 per cent.			
5. **Muzzle,** broad, mouth large; nostrils large and open	1		
6. **Eyes,** large, clear, placid	1		
7. **Face,** short; jaw strong	1		
8. **Forehead,** broad, full	1		
9. **Ears,** medium size; fine texture	1		
10. **Neck,** short, thick, blending smoothly with shoulder; throat clean with light dewlap	2		
FOREQUARTERS—9 per cent.			
11. **Shoulder vein,** full	1		
12. **Shoulders,** smoothly covered, compact, snug, neat	4		
13. **Brisket,** trim neat; breast full	2		
14. **Legs,** wide apart, straight, short; arm full; shank fine	2		
BODY—30 per cent.			
15. **Chest,** full, deep, wide; girth large; crops full	4		
16. **Ribs,** long, arched, thickly and smoothly fleshed	8		
17. **Back,** broad, straight, thickly and smoothly fleshed	8		
18. **Loin,** thick, broad	8		
19. **Flank,** full even with underline	2		
HINDQUARTERS—14 per cent.			
20. **Hips,** smooth	1		
21. **Rump,** long, wide, level; tail-head smooth; pin-bones wide apart, not prominent	3		
22. **Thighs,** deep, full	4		
23. **Twist,** deep, plump	4		
24. **Legs,** wide apart, straight, short; shanks fine, smooth	2		
Total	100		

How to Examine a Fat Steer.—When inspecting a fat steer, note from in front the general appearance of the *head,* for refinement of features, and any indications of coarseness; width of *forehead;* length and cleanness of *face;* size of *muzzle;* size and quality of *ear* and *horn;* and proportion of head to rest of body. The *head* should be short, broad and refined, the *muzzle,* large and broad, and the jaw strong. The ears and horns should be of fine texture and the features of the head have a well defined, clear-cut appearance and the head itself be of proportionate size to the rest of the body. Objectionable things about the head are narrowness, extreme length, coarse features, small, delicate muzzle, or lack of proportion in size between the head and the rest of the body.

From a slight angle to the right of the animal observe the width and smoothness of body, as shown in chest, shoulder, ribs, back, loin, hip and rump. The *body* should be broad and smooth. The *chest* should be wide and deep with the *fore legs* short, straight and standing far apart, the fore flank should be full and not sunken behind the fore leg. The *shoulders* should fit smoothly into body without a tendency to flatten on top or show prominence of shoulder blades. The lower part should be smooth, well covered with flesh and not heavy, coarse nor unduly prominent. The body behind the shoulders should fit smoothly into them and be more than full enough in *ribs, back* and *loin* to form a straight line from shoulder to hip. Any tendency to be flat in the rib or to be narrow or thin in back and loin must be discriminated against. The hips should fit smoothly into the body and be entirely covered by flesh, showing no prominence nor unevenness, and the rump should carry out full and show no tendency to droop beside the tail-head. The paunch must not be large and should be very little wider than the shoulder or thigh because a large paunch means a very large amount of waste in dressing.

Passing farther around the animal so that a full side view is obtained, note the length and cleanness of *neck* and its manner of fitting the shoulder at the shoulder vein, and the general outline of the body, the top and bottom lines, the depth and fullness of *hindquarters* and size and length of leg.

The *neck* should be thick but short, thus avoiding a large amount of cheap meat yet indicating good muscular development throughout the entire body. It should be free from dewlap or heavy skin and exceedingly large brisket and fit smoothly into the shoulder on both top and sides. The *body* when viewed from the side should present the general outlines of a rectangle, the *top line* being straight from head to tail with no tendency to droop either in front or behind of shoulder or on the rump; nor sag or be low in the back. The bottom line should be low, straight and parallel

to the top line, showing no tendency to be high in the flanks nor too low in the middle, due to an excess of paunch. The *brisket* need be only large enough to fill out the outlines of the body, the *chest* should be deep and full and the hind flank on a level with the lower line of the body which should stand on straight, short legs. The *thighs* should be deep, plump, full and extend well down to the hock.

Moving toward the rear of the animal, note from the changing viewpoint the different parts of the animal until a position in the rear is reached. From this position observe the depth and width of *hindquarters,* size of paunch, width and straightness of back, smoothness of *hips* and fullness of *rump.* The *hindquarters* should be deep and as broad as the shoulders. Paunch or belly must be very little wider than shoulders or thighs. The back as seen from the rear must be straight and not droop behind the shoulders nor in front of hips and be very broad and thickly fleshed. The hips should be smoothly covered and show no prominence. The rump should be filled with flesh on either side and gradually round off smoothly from hips to tail-head. Passing around the animal on the other side observe the various parts of the animal from all angles until the right side is again reached when the hands should be used to test the quality and thickness of flesh, or the condition, which it is impossible to do without handling. The best quality of flesh feels under the pressure of the hand to be firm yet elastic and is free from any rough places such as rolls, lumps, patches, ties and bare spots. Rolls are most commonly found on the ribs. Lumps and patches usually occur on the back, ribs and rump. These three objections are all of the same nature in that they are due to the fat having been laid on in larger amounts in some places than others and denote not only that there is a loss by having an excess of fat to be trimmed off before use but also that the fat is unevenly distributed through the lean, thereby injuring the quality of the meat. They can be easily detected by placing the hand upon the flesh. If it is smooth, firm and elastic it is of the proper quality, but localized hardening of the fat, as if in pockets, indicates the presence of undesirable fat. Ties are found commonly in the back but occasionally around the tail-head and are depressions where the skin is closely attached to the bone and cause unevenness of flesh. Bare spots or places where the flesh is very thin are most liable to occur on the shoulder, loin, back, or lower ribs and are due to uneven distribution of flesh. Press the fingers against the flesh (beginning on the shoulder and continuing toward the rear) in order to detect any of the above mentioned defects. The ideal flesh is even in all parts so that the hand can be moved over the

body without a depression or rough place being found. Avoid a soft flesh or one that is harsh and inelastic. In handling a steer, feel the flank in order to see that it is filled with fat until there is no loose, pendulous skin.

Comparative Judging.—After a thorough and systematic examination of all the animals in the ring, the next duty is to decide which one of them is the best. This can be done only by balancing the good and bad points of one animal against the good and bad points of another. There is no definite rule that can be laid down as to what should be done in all cases. This depends upon the extent of the defect or excellence and the question may be decided differently in almost every instance. In comparative judging, great stress must be laid on the uniformity of development. If there is no great difference in other things, discrimination should be made against the animal showing a decided weakness in any one of the following parts: form, quality, condition, head and neck, forequarters, body, or hindquarters. In balancing the weakness and excellencies it is often desirable to place the steers side by side and compare them part by part. For this reason and also to designate to the audience how the animals are placed, the first prize specimen is placed at the extreme end of the ring, second prize next and third next, etc. Do not let a weakness in a minor point overbalance an excellence in an important one. Other than that, the animal having no exceptionally weak parts must receive preference to one with some parts better and some parts worse than the well balanced beast.

FEEDER OR STOCKER CATTLE

When judging thin cattle it must be borne in mind that the final end of the steer is the butcher's block. Therefore the animal that gives promise of finishing into the best killing steer would seem to be the best one to select as a feeder. This is in general true in that the animal must be one that when fat, will dress out well and return a high percentage of the most valuable cuts. There are, however, some limitations, in that, while the butcher demands a very fine bone and as little paunch as possible, the feeder has found that a steer having medium sized bone and a more rugged constitution is enough more economical as a producer to offset the disadvantages of having the extra bone, and that a steer in order to be a good gainer must have enough middle to consume a large amount of feed.

The head requires much greater emphasis in a feeder than in a fat steer because the head instead of being only so much weight to be considered among the cheaper parts of the body, is a good indication of the fattening and gaining capacity of the animal. A

short, broad, clear-cut head with a large muzzle and mouth, strong jaw and quiet eye, indicates a quick fattening, rapid gaining steer that can be quickly made ready for market; a long, narrow head and fine muzzle indicate delicacy and poor feeding qualities, while a coarse, large head or wild disposition shows that the animal will require a long time to fatten and in the former case be a poor killing steer when finished. When viewed from the side, the feeder should present a short, blocky appearance, short, thick neck, straight back, deep body and short legs, as these are almost sure indications of easy fattening and early maturity which are the



Fig. 41. Fancy selected feeder. Short broad head; short, thick neck; straight back; deep broad chest; capacious middle; deep flank; full quarters; quality and symmetry throughout

principal features to be sought in a feeder in addition to the demands of the butcher which otherwise coincide with the requirements of the feeder. The middle, however, should be large and broad, and the flanks low. The chest must be deep and broad to give constitution and vigor. The ribs must be long and extend well back to the hip points as a long space between them indicates slow maturity and a thin loin when fat.

When viewed from behind the ideal feeder or stocker, presents a smooth appearance in the hip region which must not be unduly

large but be capable of becoming covered smoothly when the animal is finished. The rump must not be drooping or sharp, the thighs must be full and deep, the ribs be arched and as broad as the shoulders, thus giving a wide back and showing that the body of the animal will be evenly covered when fattened. The shoulders must be snug on top with no undue prominence at their points.

Handling the skin on a feeder is one of the easiest ways of telling the thrift of the animal. The skin is an extension of the intestinal walls and reflects the condition of the digestive tract. A tight, harsh, papery skin indicates an unthrifty, poorly nourished



Fig. 42. Inferior feeder. Shows poor feeding characters; shallow, narrow body; long legs and neck; poor constitution; high flank; angular and delicate throughout

animal, while a loose, mellow, pliable skin shows that the conditions of the internal organs are such as to make rapid gains and indicates future progress. A thick, coarse hide indicates a coarse flesh of poor quality. When taken in hand the skin should feel elastic, loose and mellow and the hair should be soft and silky indicating good health and vigor.

BREEDING CATTLE

The first essential in breeding cattle is the same as for other classes of beef animals, i. e., the true beef form must be present in a very marked degree. There is no fundamental difference in

form between breeding beef animals and feeders or fat steers. The same deep, broad, thick-set animal as described under the butcher and feeder types is the one the breeder is trying to produce. The breeding stock adheres more closely to the feeder type in that the indications of early maturity and easy fattening must be very pronounced. These indications, as has been pointed out, are shown by the short, refined head and neck, deep, broad body, low flanks, straight top and bottom lines, and short legs. The handling quality of breeding stock when in breeding condition should be much the same as in feeding cattle. The flesh should be



Fig. 43. Depth and width of chest, deep middle and thick natural flesh desired in breeding stock. Hereford cow

of almost the same thickness and the skin be very soft, mellow and elastic. When breeding cattle are prepared for show, their handling then is more comparable to that of a fat steer. The flesh should be thick, smooth and firm. The only point of difference between the two classes is that more mellowness is demanded and a lack of firmness can be more easily overlooked with breeding stock than with fat steers.

When judging cattle to be used for breeding purposes, attention must be paid not only to the requirements of the feeder and butcher, but to any indications in the animal that such good qualities as he or she possesses will be transmitted to their offspring. The best animal on earth that will not transmit his good characters

is of far less value as a breeder than one having desirable characters in a much less marked degree but having the ability to impress upon his offspring such good characters as he may possess. The good breeding animal in addition to having the characters demanded by butchers and feeders must have not only the physical ability, as shown by constitution and vigor, to produce good offspring but also the sexual ability or prepotency as shown by sex development and breed characters to impress his own good qualities upon his get.



Fig. 44. Strong burly head; well developed crest; strong shoulder and general masculine yet refined appearance. Shorthorn bull

Constitution is the result of a strong development of the vital organs of the body and is associated with a deep, broad chest, straight back, round, well sprung ribs and a deep middle and flank. A narrow chest or flat ribs as seen from in front, a shallow chest, weak back, shallow body, and high flank as seen from the side are almost certain indications of a lack of constitution and vigor. A long, narrow head, small muzzle, extreme refinement in the head and legs and a thin skin indicate a weak constitution. There is also something about the style and carriage of a breeding animal that indicates vigor and strength. A sluggish, dull or slovenly car-

riage indicates lack of vigor and vitality, while an active, stylish manner and carriage shows a reserve force and power that is always found in the best breeding animals.

Sexual Development which is an indication of prepotency is shown by a development of secondary sexual characters. In the bull it is seen in a strong, masculine head with a full forehead, strong horn and withal having the appearance of being heavy and burly but not coarse; a strong, full neck, surmounted by a heavy, well developed crest; and in the strongly developed shoulders that



Fig. 45. Refinement of features; freedom from crest; and general feminine appearance. Aberdeen Angus cow; first prize at Royal, England, in 1906-7

while being strong and showing extreme development show no roughness or coarseness. The appearance throughout is in striking contrast to the refinement due to femininity. The skin is thicker and heavier, the hair is not so silky and soft, and impression is conveyed at once of a strong, active, masculine being, and yet there is a refined appearance indicating the presence of the greatest amount of quality associated with such masculinity and sexual development.

Indications of prepotency in a female are shown by very great refinement in all parts of the body. The head should be entirely free from the burly, heavy appearance seen in the bull; the forehead should be full and broad but not heavy; the horns should be finer; the neck should be more refined and thinner than a bull's and

be entirely free from crest; the shoulders should show no extra development and fit smoothly with the rest of the body. The skin should be thinner, mellower and more elastic; the hair be silkier; and there should be greater development in the hips which should be wider and more prominent than in a bull.

There ought to be throughout an appearance of refinement and femininity strikingly in contrast to the masculine look of a bull.



Fig. 46. Adherence to breed type indicates prepotency



Fig. 47. Uniformity adds value to the breeding herd

Prepotency is indicated in both sexes by close adherence to the characters of the breed to which they belong. Continuous years of breeding have fixed certain characters in breeds that while not necessarily responsible for good beef form, are closely associated with it in that particular breed. Any tendency of an animal, therefore, to break away from the characters of the breed to which it belongs is an indication of reversion or breeding back to unimproved ancestry. For this reason, an animal should be characteristic and typical of the breed to which it belongs as well as of a good beef animal.

PART IV

JUDGING DAIRY CATTLE

P. H. Crane, Associate in Milk Production

INTRODUCTION

Methods of Judging.—Good cows are the first essentials for profitable dairying. Profitable dairy cows are those that make the maximum production on the minimum amount of feed. In general there are two methods used in the selection of dairy cows. The first method is the selection of cows from known records of milk production as determined by the use of the Babcock test[1], and scales; the second method is the selection by conformation or type of the animal.

The first method is the only strictly satisfactory way in which to judge of the cow's ability as a producer of milk and butter fat. Where cows are selected for the dairy or where they come up for judgment in the show ring, it is not always possible to know the records of production. Such records have not been generally kept, but dairymen are beginning to realize the necessity of knowing the annual production of their individual cows, and many are having official tests made. This is done by a representative of the Agricultural Experiment Station, who is present when the cows are milked, weighing and sampling each milking. A fat determination is made of each sample by the tester, while a composite sample is sent to the Agricultural Experiment Station to be tested, as a check. These tests may be continuous seven day tests, continuous 30 day tests, or two day per month yearly tests. In the last named test, samples are taken two consecutive days in each month and the milk is weighed each milking throughout the year. This is known as the semi-official yearly test, the total production being calculated on the production represented by the 12 tests. The results of the official and semi-official tests are accepted by the various dairy cattle breed associations for advanced registry or register of merit[2], as the case may be. Private testing is being done by many, in a manner resembling the semi-official yearly test, which method gives a good estimate of the cow's value as a producer.

[1] Babcock test.—A simple method of determining the per cent. of butter fat in milk

[2] Advanced Registry.—The national registry associations recording pure-bred dairy cattle, maintain a record in which animals of especially high performance are recorded. Records of production, admitting animals to advanced registry, or register of merit, must be made under the supervision of the association and a state experiment station. Bulls may be recorded upon their records as producers of advanced registry cows. Full information may be obtained from the associations

The second method, the selection of cows by dairy type or conformation, has to be relied upon more often than the first method. There is no doubt that there is a certain type or form that is associated with high milk production. This type or form of the dairy cow is, to a large extent, acquired. Before cattle were domesticated, it is highly probable that the cow gave only enough milk for the calf until it could subsist upon other foods. It is undoubtedly true that the beef animals we have today are descendants of these same cattle, but by careful selection and breeding, the several breeds of dairy cattle have been developed. Some of the dairy breeds have been handled and bred as separate breeds for hundreds of years



Fig. 48. Arteries (in white), leading from the heart to the udder. Veins (in black), leading from the udder to the heart

until their conformation, their milk and butter fat producing ability have become fixed and are transmitted with marked certainty.

Comparison of Form and Performance.—Whether or not the form of a dairy cow is the result of her function, or function the result of form, is still an unsettled question. It is certain, however, that performance is demanded and experience has proven that there are certain requirements of form necessary to high production. The form of the cow must be such as will permit of the greatest possible development of the organs primarily important to milk production. There must be strength of jaw, capacity of muzzle, stomach, and other organs of digestion, in order that large amounts of

feed can be masticated and digested. Coordinate with the digestion, there must be a circulatory system of sufficient capacity to carry the nutrients from the digestive apparatus to the heart where the blood bearing these nutrients is pumped out through the artery (a, Fig. 48) leading to the udder, the real factory where the nutrients in the blood are made into milk. The process of milk secretion is not clearly understood and about all that is known definitely is that milk is a product made from the materials brought to the mammary glands by the blood and lymph. The process is not that of filtration or giving up of the materials in the blood in the exact form they are found in milk, but is a process of manufacturing, an



Fig. 49. A poor type of dairy cow, showing lack of capacity throughout

entirely new product being made from the materials in the blood. This new product is an emulsion consisting of very finely divided fat, suspended in a solution consisting of water, sugar, casein, albumen and ash in slightly varying proportions in different samples of milk. It is evident that there must be sufficient capacity of circulation to care for the large quantities of blood that must be carried through the arteries, to the udder where the nutrients are given up, and back through the veins, from the udder to the heart. The amount of milk secreted in a given length of time will also depend largely upon the size, shape, texture and quality of the udder.

When the cow has a strong tendency to change the feed consumed above maintenance requirements into milk, she is to be

classed as a dairy cow and as such, her production will depend largely upon her capacity of digestive, circulatory and mammary organs, provided that she is fed and cared for properly. With the proper development of the various parts as demanded by the function of milk production, the resulting animal has a characteristic dairy cow conformation.

General Appearance.—The conformation of the dairy cow is such that her general appearance distinguishes her from cows of other classes. She is thin or spare in flesh, angular and loose jointed. Her body is muscular, coat smooth and soft, eyes bright, and in disposition she is wide awake, showing that her thin appear-



Fig. 50. Wedge shape as seen from the side, base, b-c, apex a

ance is not due to lack of feed or the ravages of disease but to her inherent tendency to convert her feed into milk instead of body fat.

The general angularity of the cow gives her what is known as the wedge conformation which is very evident in the typical dairy cow. This conformation outlines distinctly three wedges.

When the cow is viewed from the side, one of the wedges is seen with the base formed by the depth through from the hips (b) to the lower extremity of the udder (c), and the apex or point of the wedge at the head (a), as shown in Fig. 50.

When viewed from the top, the dairy cow's peculiar form presents a second wedge with the base, formed by the great width across from one hip point to the other, (b to c) and the apex at the withers (a), as shown in Fig. 51.

The third wedge is seen when the cow is viewed from the front. The base of this wedge is formed by the wide floor of the chest (b to c) and the apex by the withers (a), as shown in Fig. 52.

This wedge shape is found to a greater or less degree in all dairy cows, and is sought after, alike for the dairy, and for the show ring.

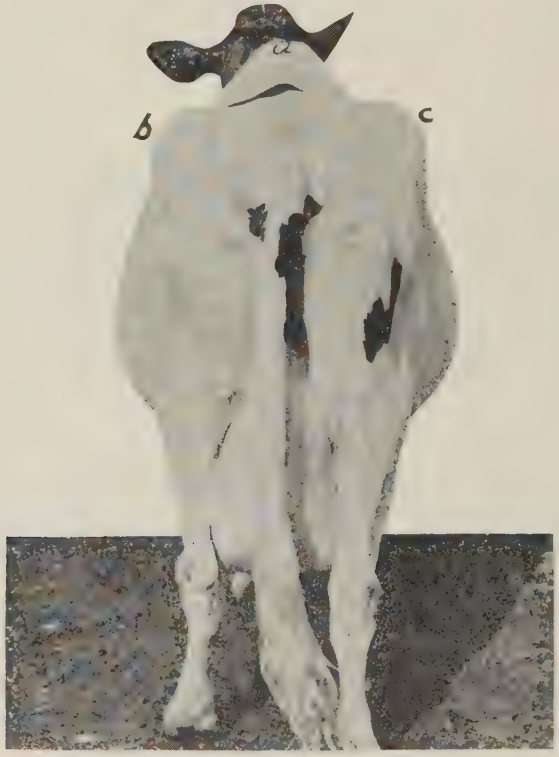


Fig. 51. Wedge shape as seen from above and behind, base, b-c, apex, a

THE DAIRY COW

Score Card.—In the judging of a dairy cow, all points that have any relation to milk production and symmetry of form should be considered. If the dairy cow is a pure-bred animal and is to be judged as such, there are a few points to consider other than those when judging any cow as a dairy animal.

In order that no point escapes notice, some system must be followed in looking at an animal, and this system can be acquired by the use of a score card. Study the score card until the location, ideal conformation and the relative value of all parts of the dairy cow are well in mind. This can best be done by using the score card carefully on a number of cows whose value as milk producers is known and in this way a fairly good idea may be formed of the number of points to deduct from the perfect score when a part is defective.

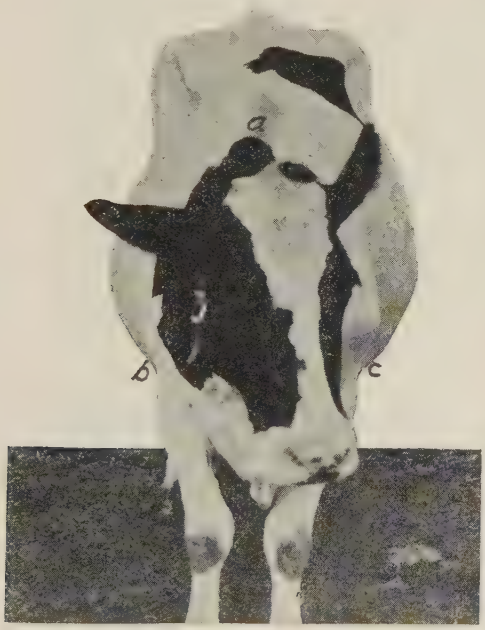


Fig. 52. Wedge shape as seen from the front, base, b-c, apex a

In judging a dairy animal see that it stands in a natural position on a level surface and that the attendant does not hide any defects from view.

Begin by taking in the general appearance, and note whether or not the animal belongs to the dairy class. This can best be done by walking around the cow three or four paces distant, viewing her from the front, side and rear. If she has the general appearance, as previously described to a degree to class her as a dairy cow, then begin a careful, systematic examination.

The system followed in the score card is to begin at the nose of the animal and go back over the body, considering every part.

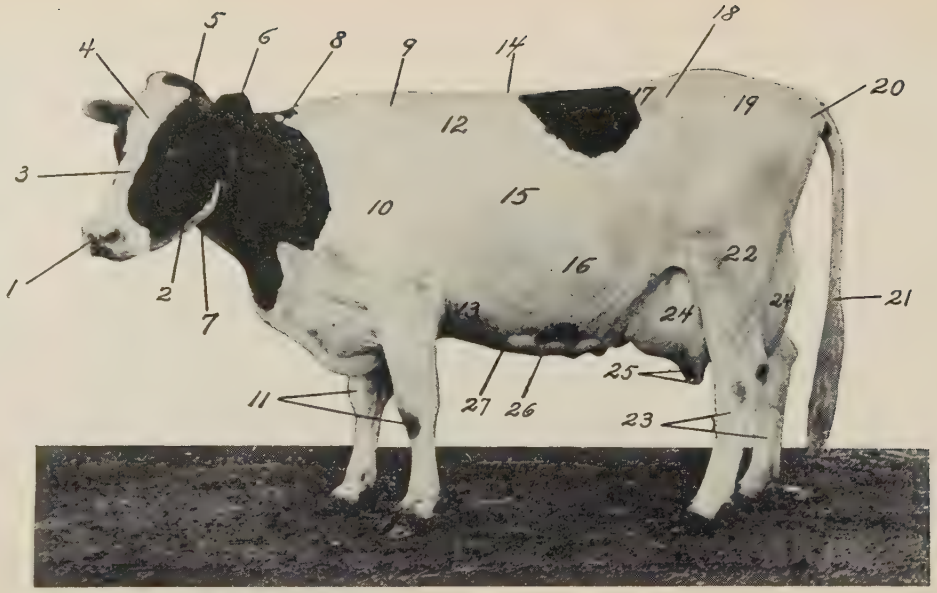


Fig. 53. Parts of a dairy cow. Holstein cow, "Colantha Bakker 4th, 57516, A. R. O. 12893," Purdue herd

1.	Muzzle	8.	Neck	15.	Ribs	22.	Thighs
2.	Jaw	9.	Withers	16.	Barrel	23.	Hind legs
3.	Face	10.	Shoulders	17.	Loin	24.	Udder
4.	Forehead	11.	Fore legs	18.	Hips	25.	Teats
5.	Eyes	12.	Crops	19.	Rump	26.	Milk veins
6.	Ears	13.	Chest	20.	Pin bones	27.	Milk wells
7.	Throat	14.	Back	21.	Tail		

THE SCORE CARD

DAIRY CATTLE — COW

SCALE OF POINTS	Standard	Points deficient: Student's score	Points deficient: Corrected
HEAD—8 per cent.			
1. Muzzle, broad	1		
2. Jaw, strong, firmly joined	1		
3. Face, medium length, clean	1		
4. Forehead, broad between eyes; dishing	1		
5. Eyes, large, full, mild, bright	2		
6. Ears, medium size, fine texture; secretions oily and abundant, yellow color	2		
FOREQUARTERS—10 per cent.			
7. Throat, clean	1		
8. Neck, long, spare, smoothly joined to shoulders, free from dewlap	2		
9. Withers, narrow, sharp	3		
10. Shoulders, sloping, smooth; brisket light	3		
11. Fore legs, straight, clean, well set under body	1		
BODY—25 per cent.			
12. Crops, free from fleshiness	1		
13. Chest, deep, roomy; floor broad	6		
14. Back, straight, strong; vertebrae open	3		
15. Ribs, long, deep, sprung, wide apart	3		
16. Barrel, deep, long, capacious	10		
17. Loin, broad, strong	2		
HINDQUARTERS—12 per cent.			
18. Hips, prominent, wide apart	1		
19. Rump, long, level, not sloping	4		
20. Pin Bones, wide apart	1		
21. Tail, neatly set on, long, tapering	1		
22. Thighs, spare, not fleshy	3		
23. Hind Legs, well apart, giving ample room for udder	2		
MAMMARY DEVELOPMENT—30 per cent.			
24. Udder, large, very flexible, attached high behind, carrying well forward; quarters even, not cut up	15		
25. Teats, wide apart, uniformly placed, convenient size	5		
26. Milk veins, large tortuous, extending well forward	4		
27. Milk wells, large	6		
GENERAL APPEARANCE—15 per cent.			
28. Disposition, quiet, gentle	2		
29. Health, thrifty, vigorous	3		
30. Quality, free from coarseness throughout; skin soft, pliable; secretions abundant; hair fine	4		
31. Temperament, inherent tendency to dairy performance	6		
Total	100		

For convenience in the discussion of the different parts of the dairy cow, the same numbers are used in the score card and in Fig. 53, to indicate the parts of the cow.

Head—8 per cent.—Look at the muzzle by raising the cow's head slightly, if necessary. It should be broad, showing capacity, as a broad muzzle is associated with a good feeder. A pinched muzzle should be discriminated against as this character is transmitted very readily and is taken as an indication of lack of constitution and capacity. By running the hand along on the under side of the jaw from the mouth to the throat, the character of jaw bone may be ascertained. It should be strong of bone, muscle and attachment to the upper jaw, so that large quantities of feed can be properly masticated. The face of the cow can be seen best from the front. It extends from the muzzle to the forehead and should be of medium length and free from extra flesh, as a clean-cut face indicates quality and dairy temperament. From the same position, the forehead is seen and should be broad and slightly dished. Here is the seat of the important part of the nervous system, the development of which is a requisite of the high producer.

Note also the eyes, which should be large, full, mild and quiet, as they indicate temperament. The drowsy eye is not associated with milk production. In judging the ears, it may be necessary to handle them. Care should be taken at all times to be gentle and careful in handling a dairy cow. The ear should be of medium size, fine in texture, and show, especially on the inside, an abundance of yellow, waxy secretion. The size and texture of ear indicate quality, and the character of secretion is supposed to indicate, to some degree, the quality and coloring of the milk secreted.

Forequarters—10 per cent.—Step to one side and view the throat, supplementing this if necessary by grasping the throat in the hand. It should be clean-cut and thin. Frequently this part will be found thick and beefy, which shows lack of dairy character.

From about the same position, note the neck of the animal. It should be long, spare, and smoothly joined to the shoulders; a direct contrast to the short, thick neck of the beef animal. Frequently loose skin, known as the "dewlap," hangs in folds from the lower part of the neck. This is undesirable.

Take another step toward the rear of the cow, placing the hand on the withers. By an examination with the hand and by glancing down along the neck, withers and back, from above, a good idea may be formed of the conformation of this region. The top of the shoulders and spinal column should fit up together in such a manner as to form sharp withers. It is not uncommon, however, to find

cows with coarse or open withers, often times so wide across that this region can not be spanned with one hand. This should not be the case as it is an indication of either beefiness or coarseness.

Standing a pace or two to one side of the cow on a line with her head, observe the shoulders and fore legs. The shoulders should be sloping to insure capacity of chest, and smooth, to show quality and trimness. The brisket should be refined.

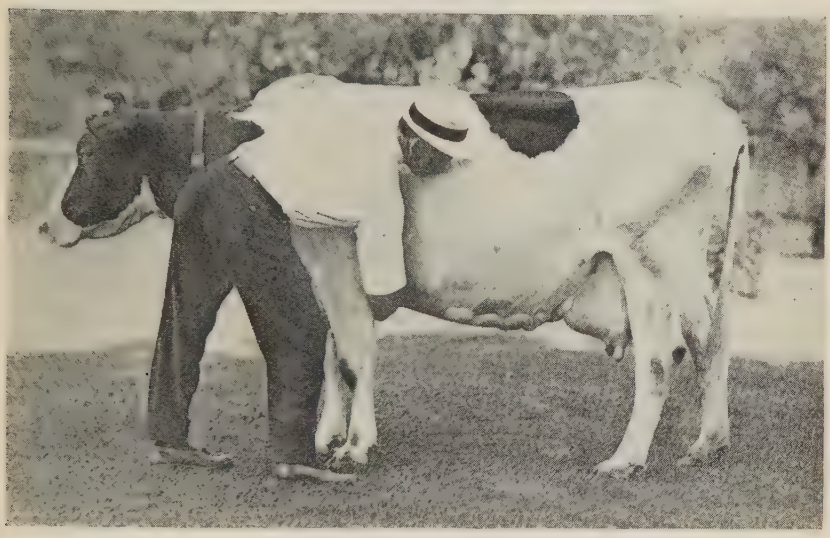


Fig. 54. Estimate width of chest floor with right arm

The fore legs should be set squarely under the cow far enough apart to give sufficient capacity of chest. They should be straight and trim, indicating quality and substance sufficient to strongly support the animal. Frequently they stand too close together, which is quite objectionable as it reduces the space for the heart and lungs.

BODY—25 PER CENT.—Pass the hand along the spinal column, immediately back of the withers and note the condition of the chine. This portion should be free from fleshiness, but on a cow somewhat inclined to lay on fat, will often be full and rounding.

Judge the width of chest by passing the hand under the cow's body just back of the fore legs, as in Fig. 54; then step back about two paces and note the depth of chest. It should be broad and deep

giving great capacity for the heart and lungs which are important factors of constitution.

The back may be viewed from the last named position and should be straight and strong. By stepping up to the cow and passing the open fingers along the spinal column, the top of the spinal processes may be felt. These should be quite noticeable and not closely joined as the lateral nerves pass out between the vertebrae from the spinal cord and plenty of space for these nerves is desired. A very common defect is a weak back or one that is not straight. Although it is not considered a very serious defect for a cow to be a little low in the back, it is to be discriminated against.

Let the hand follow the ribs from the spinal column to the lower extremity, noting length, spring, and the width between the last two or three ribs. The spring of rib can be noted to advantage by stepping back of the cow and looking down on her body from above. She should have long, well-sprung ribs that are wide apart laterally, giving great capacity of chest and barrel. One of the most common defects of this part of the cow is the lack of spring of rib and lack of space between ribs. The last two or three ribs should be far enough apart to admit two or three fingers between them.

Bearing in mind the spring of rib, step to the side of the cow again at two or three paces distant and note capacity of barrel. It should be deep, long and wide, giving that roominess without which great consumption of feed is impossible. This point must be criticised severely if the cow does not show capacity.

The appearance of the loin as viewed from the side and rear is generally sufficient to give an idea as to its character. It should be strong and broad, as strength and capacity in this region are demanded to support the heavy load of the abdomen and prevent difficulty at time of parturition. The most common defect here is a narrow loin.

HINDQUARTERS—12 PER CENT.—From the rear note the width between the hips. They should be prominent and wide apart. This is necessary to capacity of barrel and room in the pelvic region. Discriminate against lack of width.

Stand at the side of the cow, opposite her hindquarters, and look at that part of the cow between the hip point and pin bone, the rump. It should be long and level. The length is important as it is correlated with the space for attachment of udder below. A sloping rump is a frequent fault and detracts from the symmetry of the hindquarters.

Step back to the rear of the cow again to note the width of pin bones. They should be wide apart, as width in this region conduces to easy parturition.

From the same position as last indicated, note the length and quality of tail, and then by stepping to one side obtain a view of the tail setting. The tail setting should be level and neat, the tail dropping down squarely. The tail should be long, tapering, and of good quality. It is desirable to have the extremity of the bone of the tail reach the hock at least. The most common defect of this part is a high, or a sloping tail setting; the former is the less objectionable.

Get a view of the thighs, both from the side and rear of the animal. They should be thin and incurving as viewed from the side, and wide apart, the width being carried well up. The most serious fault usually found in this part is thick heavy thighs carried down low, lessening space for development of udder.

Stand back of the cow and note the position, conformation and quality of hind legs. They should stand well apart, showing trimness and good quality. The common defect with the hind legs is that they are liable to be close together at the hocks, which is objectionable as it limits the space for the udder.

MAMMARY DEVELOPMENT—30 PER CENT.—A thorough examination should be made of the udder, as it is one of the most important parts of the dairy cow. Note the width and general character by standing at the left side and rear of the cow, then come to the cow upon the right side and make a thorough examination with the hand, noting quality, shape, attachments, and size of udder. It



Fig. 55. A well developed udder with evenly placed teats. Note development of fore-udder. Ayrshire cow, "Florence Melrose 18975, Advanced Registry 368," Purdue herd



Fig. 56. Estimate length of udder, from attachment in front to attachment in the rear



Fig. 57. Udder attached high behind and of good quality, shown by numerous folds when milked out. Ayrshire cow, "Florence Melrose 18975, Advanced Registry 368," Purdue herd

should be long, not pendulent, but long from the attachment in front to the attachment in the rear. It should have a level floor with quarters well balanced. It should be of fine texture and not meaty, so that when milked out it will hang in folds. (Fig. 57) There are a number of different types of udders that are not desirable. The pendulous udder (Fig. 58) gets dirty and is injured easily and the secretory organs are farther removed from the blood supply than is the case with the long udder that is closely attached to the body.



Fig. 58. A pendulous udder, easily injured and soiled

The funnel shaped udder (Fig. 59) is undesirable as it lacks capacity. The fleshy udder is objectionable because there is not enough room for secretory glands, the larger portion of it being taken up with connective tissue and fat. Then too, care must be taken to detect any bad quarters.

When the examination of the udder has been completed, the teats should be grasped and a stream drawn from each one. The teats should be evenly placed, of convenient size, and far enough apart to prevent interference while milking. Many times the teats are small, uneven in size, very tapering, or bunched, all of which

conformations are objectionable. By passing the hand along the cow's belly forward from the udder, the veins leading from the udder to the heart will be felt. These are known as the milk veins and are the only accessible indicators as to the amount of blood that can pass through the circulation leading to the udder. Although known as milk veins they do not have milk in them at any time,



Fig. 59. A funnel-shaped udder, with little capacity

but carry the blood from the udder to the heart. (Fig. 48) This visible indication of the circulation to the udder is important and should be long, large, tortuous and branched. Following the milk veins to their extremities, openings in the body wall can be found with the finger. (Fig. 60) These openings are where the milk veins pass into the body cavity and are known as the milk wells.



Fig. 60. Determine size of milk well with right fore finger



Fig. 61. Examine quality of hide and hair

These wells should be large and, naturally, as numerous as the branches of the milk veins. They regulate to a considerable extent the capacity of the milk veins, consequently small milk wells should be discriminated against.

General Appearance—15 per cent.—After the careful consideration of each individual part of the cow, it is well to consider the entire animal again in a little more accurate manner than in the beginning. From the behavior of the cow while being handled, an opinion can be formed as to her disposition. She should be gentle and quiet, but also show strong nervous temperament well under control, as such is necessary to high milk production.

The health and vigor will be indicated by her general alertness, character of hide and strength of constitution, as indicated by a deep, broad chest, strong frame and wide-awake appearance.

By the detailed examination already made of the various parts, the general quality is noted. In addition to this, the handling quality may be ascertained by gathering up a handful of the hide just over the last two or three ribs. (Fig. 61) The hair should be soft and fine, hide thin and mellow, and the secretion in the ear, and over the body, of a yellow, waxy appearance. All of these indicate that the animal is fitted to perform the particular function of converting feed into milk and butter fat in an economical way.

From a last general view taken by walking around the cow, the first general impression may be confirmed or changed as the case may be, as a result of a detailed study of the animal. She should make an impression of having that dairy temperament, or tendency to change her feed into milk instead of body fat, demanded in the dairy cow.

This character should be reflected in every part individually and in all parts taken collectively.

Comparative Judging.—Comparative judging of dairy cattle is the form of judging employed almost exclusively by the show ring judge, the breeder of pure-bred dairy cattle, in his selection of breeding animals, and by the dairyman in his selection of dairy cows.

It is the estimation of the relative merits of individuals as compared not only with an ideal but also with other individuals. For a fair comparison, the animals should be of the same sex, breed, of about the same age, and in about the same period of lactation.

A thorough examination of each individual is necessary before a comparison can be made. This should be systematically done as outlined in the preceding discussion. Weigh the merits and demerits of each animal with those of every other animal under consideration, paying particular attention to mammary development,

capacity of barrel, constitutional vigor, symmetry of form, quality and disposition, placing the animal in first place that possesses these important points developed to the highest degree, bearing in mind the relative importance of these different qualities in a dairy animal.

Good judgment must be exercised in determining the degree of difference in the same parts in the different animals, and the consideration that is due such difference in view of the relative importance of parts.

THE DAIRY BULL

There are two methods of judging the merits of a dairy bull, as has also been pointed out in the case of the dairy cow.



Fig. 62. A pure bred dairy bull, typical of the breed, the merit of which has been proven by the increased production of his daughters over their dams. "Gorgeous Boy 67767, Register of Merit 70," Purdue herd

The first is that method based upon performance or the ability of the bull to stamp his good characters upon his offspring. He should be able to increase the production of his daughters over that of their dams and maintain the breed characters of conformation.

When this method of selection is practiced, only aged bulls can be considered and records of his progeny must be known. This condition of affairs is very seldom found, so that it is necessary to resort to a second method of selection or judging the merit of dairy

bulls, that is, judging by pedigree and records of ancestors along with the conformation of the individual.

The dairy sire should be a pure-bred animal of the breed he represents and should have in his immediate ancestry females that have good yearly production records, and sires that have tested daughters. The records and conformation of the dam, granddam and their sisters are good indications of what may be expected of the bull. After the proper precautions have been taken, as to breeding and production records back of the bull, then the estimation of the merit of the animal as to his conformation can be taken up.



Fig. 63. A grade bull; a type that should go to the block, before further damage is done

The judging of the dairy bull from the standpoint of conformation, is done in much the same manner as the judging of the cow. The same system should be used in going over a bull in detail as given in the previous explanation of the score card, with a few necessary variations. The attendant should always handle the bull with a staff, and the judge should be careful while handling the animal.

The dairy bull should be typical of the breed he represents and should show, in general, the spare, angular form seen in the cow, with prominent indications of masculinity and constitution. These qualities are seen in a strong face, broad forehead, bright prominent eyes, heavily muscled neck, neatly joined to head and shoulders, a neat crest, deep, broad chest, and large barrel.

The hips do not show the same relative width as seen in the cow, but the thighs should be thin, incurving, and cut up well, making the bull high in the twist. The rudimentary teats should be of good size and evenly placed in front of the scrotum, as they indicate in some degree the size and position of the teats on the female offspring. The dairy bull should have quality as indicated by a soft, pliable hide, fine, glossy hair, strong, clean bone and abundant yellow, waxy secretions in the hair, and over the body in general.

Some of the common defects of the dairy bull, which should be discriminated against are:—a tendency to beefiness, lack of barrel, full outcurving thighs, coarseness in shoulders and head, and lack of that style and carriage which indicates strong nervous development. Greater progress can be made in the improvement of dairy stock by discriminating against grade bulls, and pure-bred dairy bulls of undesirable conformation, in favor of good, pure-bred dairy sires with desirable conformation and good production records back of them, than by any other one process.

PART V

JUDGING HOGS

W. W. Smith, Assistant Professor of Animal Husbandry

INTRODUCTION

Classification.—There are two general classes of hogs on the market, the fat or lard hog and the bacon hog. These are often spoken of as the lard type and the bacon type. The lard hog is broad, thick, low-set, and of medium length, while the bacon hog is inclined to be medium to thin in condition, narrow bodied, long and deep of sides and more upstanding. The lard hog furnishes the market with lard, cheap side meat, hams, and shoulders. The bacon hog, because of its light ham and shoulder and deep, long sides, furnishes bacon as its principal cut.

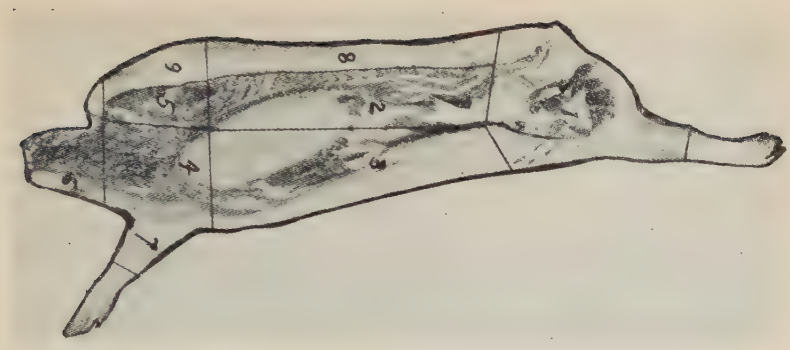
The type of hog best suited to the corn belt is the lard hog. This is largely because of the abundance and the fattening qualities of corn. For these reasons hogs of strictly bacon breeding are rarely seen on the Chicago or Indianapolis markets. As long as the demand continues for lard, therefore, the farmers of the upper Mississippi Valley will probably continue to produce the kind of hog which can use corn most satisfactorily in its ration. In Canada, where peas, barley and oats are used abundantly, and little corn, hogs of the bacon type are generally produced.

FAT HOGS

Market Demands.—The market prefers the fat hog that will "kill out" the most profitably. To yield profitable returns to the butcher or packer, the hog when killed must, first, "dress" a large proportion of carcass to waste and, second, supply a quality of meat which will please the consumer. High dressing percentage[1] and superior quality in the meat are largely what determine differences in merit and selling price. In judging fat hogs in the show ring or on the market, therefore, these two ideas—dressing percentage and quality of meat—are fundamental, and should be kept constantly in mind.

In order that high dressing percentage and superior quality of meat may be obtained, the lard hog must possess certain characters or "points". The attempt to describe or determine these essential requirements has led to the adoption of a standard. This standard, or ideal, for the lard hog is shown in the following score card.

[1] Dressing per cent.—The proportion the weight of the carcass bears to the weight of the live animal. Obtained by dividing the number of pounds weight of the carcass, by the number of pounds live weight



Bulletin No. 147, Illinois Experiment Station

Fig. 64. Wholesale pork cuts

1. Short cut ham
2. Loin
3. Belly
4. Picnic butt
5. Boston butt
6. Jowl
7. Hock
8. Fat back
9. Clear plate

2, 3, 8. Side

2, 8. Back
4, 7. Picnic shoulder
5, 9. Shoulder butt
8, 9. Long fat back
4, 5, 7, 9. Rough shoulder

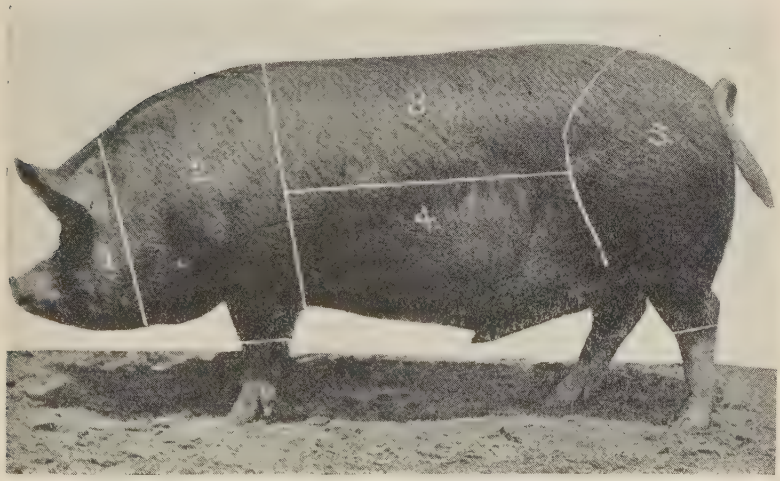


Fig. 65. Wholesale pork cuts located on the live animal. 1. Head 2. Shoulder 3. Loin 4. Belly 5. Ham Pure-bred Berkshire barrow

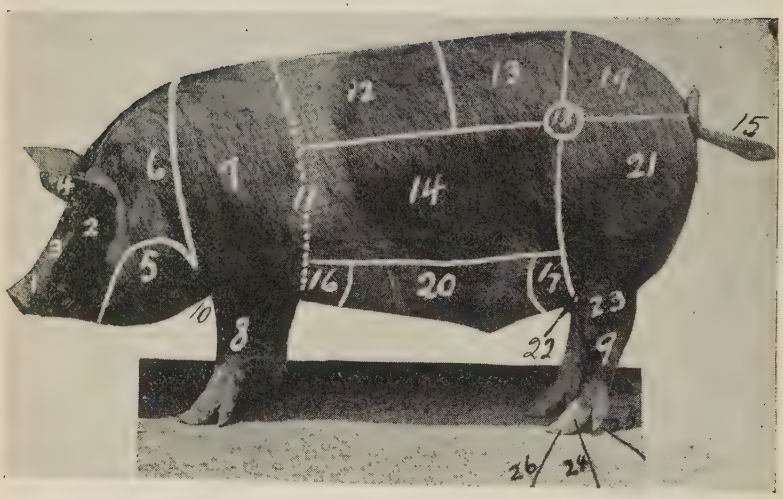


Fig. 66. Points of the hog

1. Snout
2. Eye
3. Face
4. Ear
5. Jowl
6. Neck
7. Shoulder
8. Fore leg
9. Hind leg
10. Breast
11. Chest line
12. Back
13. Loin
14. Side
15. Tail
16. Fore flank
17. Hind flank
18. Hip
19. Rump
20. Belly
21. Ham
22. Stifle
23. Hock
24. Pasterns
25. Dewclaw
26. Foot

SCORE CARD

LARD HOGS **FAT**

SCALE OF POINTS	Standard	Points deficient	
		Student's score	Corrected
GENERAL APPEARANCE—30 per cent.			
1. **Weight**, score according to age	4		
2. **Form**, deep, broad, medium length; smooth, compact, symmetrical; standing squarely on medium short legs	10		
3. **Quality**, hair smooth and fine; bone medium size, clean, strong: general appearance smooth and refined	6		
4. **Covering**, finished; deep, even, mellow, free from lumps and wrinkles	10		
HEAD AND NECK—8 per cent.			
5. **Snout**, medium length, not coarse	1		
6. **Eyes**, not sunken, clear, not obscured by wrinkles	1		
7. **Face**, short; cheeks full	1		
8. **Ears**, fine, medium size, attached neatly	1		
9. **Jowl**, full, firm, neat	2		
10. **Neck**, thick, short, smooth to shoulder	2		
FOREQUARTERS—12 per cent.			
11. **Shoulders**, broad, deep, smooth, compact on top	8		
12. **Breast**, full, smooth, neat	2		
13. **Legs**, straight, short, strong; bone clean; hard; pasterns short, strong, upright; feet medium size	2		
BODY—33 per cent.			
14. **Chest**, deep, wide, large girth	4		
15. **Sides**, deep, full, smooth, medium length	8		
16. **Back**, broad, strongly arched, thickly and evenly covered	9		
17. **Loin**, wide, thick, strong	9		
18. **Belly**, straight, smooth, firm	3		
HINDQUARTERS—17 per cent.			
19. **Hips**, wide apart, smooth	3		
20. **Rump**, long, level, wide, evenly fleshed	3		
21. **Ham**, heavily fleshed, full, firm, deep, wide	9		
22. **Legs**, straight, short, strong; bone clean, hard; pasterns short, strong, upright; feet medium sized	2		
Total	100		

A study of the score card is desirable as a preliminary to the actual work of judging a ring or class of fat hogs. After learning the various parts or "points" of the hog as shown in Fig. 66 and familiarizing himself with the descriptions of the principal points as given by the score card, the student is ready to begin the actual

work of scoring a single individual. (For general directions in the use of the score card the student is referred to page 8)

Weight; According to Age—4 per cent.—There is no fixed single weight which the packer or butcher can be said to prefer. On the Chicago or Indianapolis market, for example, there can be seen hogs ranging in weight from 50 pounds to 500 pounds. Usually, however, the pig weighing from 200 to 300 pounds commands the highest price, provided it has the form, quality, and finish which come from improved breeding and good feeding. This is a profitable weight for the farmer to produce, and should be attained by the best pigs when from six to 10 months of age. A good standard of weight for age is an average daily gain of one pound from birth. In scoring fat hogs it is not customary to make a 'cut' if the individual comes up to this standard.

Form—10 per cent.—In form, the ideal fat hog should be deep, broad, and of medium length; smooth, compact and symmetrical; standing squarely on mediumly short legs. The form or type, as it is often called, is quite well defined by these general terms. It is most important that the hog besides being broad, thick, and heavy in the back, loin, and ham, present an appearance of trimness along the belly line and jowl. His underline should be straight. He should have broad, smooth shoulders, a wide, strongly arched back, deep, full hams, full sides, and a straight, trim underline.

In scoring or judging the form of the fat hog, the student should be systematic in making his observations. It is better not to get too close, as the outline and general proportions can be more accurately observed at a distance of 10 or 15 feet. From in front, notice the width between the eyes, smoothness of shoulders, and width of back and loin. From this position, narrowness of head, rough, open shoulders, and narrow, weak back and loin will be most conspicuous. Passing a little to the left the student is in the best position to note any defect in the smoothness or fullness of the side. A straight edge applied to the side of the hog, in contact with the shoulder and ham, should touch all along the side. The width of back should be carried down uniform to the belly line. The top and bottom lines and depth of shoulder, side and ham, and length of legs can best be judged from the side. The most common and serious defects to be noted here are weak back, steep rump, high, 'cut up' flanks, narrow ham, a heavy, wrinkly underline, and a coarse, heavy jowl. They indicate excessive waste when the animal is killed and a small proportion of the most desirable cuts in the carcass. The manner in which the hog stands should also be observed. The hog that stands with his hind feet far under is usually steep and flat in the rump and does not possess the smooth-

ness and levelness of lines to make him symmetrical in appearance. Extremely long legs are to be criticised for they not only represent so much waste to the butcher, but are usually associated with a narrow back and light hams. From behind observe the width, depth and fullness of the hams, the set of legs, and the uniformity of the width throughout. The ham is one of the most important parts of the fat hog, and light, narrow, flat hams should be discriminated against. It will be observed that when a hog stands with his hind legs close together, his hams are usually lacking in weight and development. The fat hog should be as wide in the hams, loin and back as he is in the shoulders. Passing on around to the right side, the same observation should be carefully made as on the left.

The standard form or type of the lard hog is considered important by the market because of its relation to dressing percentage. The average hog on the Chicago market dresses only 70 per cent. of carcass to live weight when killed. The hog with the ideal form just described, if fat, should dress 85 per cent. or more. The range of average fat barrows is about from 78 to 82 per cent. Besides being lighter in total percentage of offal to live weight, the standard fat hog will be heavier in the more valuable cuts, namely, the back, loin, and ham. In scoring or judging the form of the fat hog, therefore, emphasis should be placed upon those things which indicate light offal or waste and superior development in the region of the back, loin, and ham.

Quality—6 per cent.—Quality refers to the character of the hair, skin, and bones and the general appearance of smoothness. According to the standard as shown by the score card, the hair should be soft and silky, the skin smooth and fine and the bone medium sized, dense and strong. The general appearance should be smooth and refined.

All of these points should be carefully observed by the student when scoring. The features of the face and head, the ears, hair, and legs are the parts especially important as indications of quality. The most frequent faults in quality are coarse, heavy head and ears, coarse bone, and coarse, curly hair and wrinkly skin.

Quality in the fat hog is an indication of the amount of offal or waste when the animal is killed. The hog with large, coarse bone, with heavy head, that is rough and coarse in general appearance, is always an unprofitable animal for the butcher to handle unless bought at a low price. In addition to causing heavy offal in dressing, coarse quality of hair and bone is thought to be associated with inferior quality and texture in the meat itself. The most important considerations in quality are general smoothness, refinement about the head and ears, and clean, strong bone.

COVERING—10 PER CENT.—Covering refers to the condition or degree of fatness and is most important in determining the selling value of the lard hog. The fat covering should be deep and even, especially along the shoulder, back, and loin. The fattest hog usually sells for the most money on the market, other things being equal, and as long as lard continues to command a high price, hogs of extreme condition will enjoy the keenest demand from the buyer. Besides being desirable in itself as lard, high finish or condition guarantees a high dressing percentage and improves the keeping and shipping qualities of the meat when cured.

The fat hog should also be smooth in his covering. If the fat covering is not smooth and free from lumps, creases, and wrinkles, the carcass when hung on the hooks will not be smooth and attractive.

The degree of fatness is judged or indicated by general plumpness and fullness of form, development of fat in jowl, belly line, and hams, and the depth of covering over the back and loin. The student may use his hand to advantage here in determining the thickness in the regions of the shoulder, back, and loin, as well as determining the mellowness of the covering. Condition or covering is of importance to the packer or butcher because of the demand for lard and its close relationship to the dressing percentage.

HEAD AND NECK—8 PER CENT.—According to the score card the head and neck constitute a rather unimportant part of the fat hog. To the butcher the head is chiefly waste, and the more refined, therefore, the better. The most important things for the student to observe here are the shape or form of the head, and the quality. A broad head, short neck and snout are usually associated with a broad back, deep, heavy hams, and feeding capacity. Quality and refinement in all the features are especially desirable because they not only indicate refinement in the carcass, but also light offal or waste.

FOREQUARTERS—12 PER CENT.—The shoulders are the most important part of the forequarters. This is indicated by the figure at the right of this point on the score card. Though the student may already have criticised the shoulder or legs when scoring the 'form' under 'general appearance,' it is the practice to make another 'cut' when the parts or details are thus considered. A full breast, deep, smooth shoulders, and straight legs showing quality are the chief considerations here.

BODY—33 PER CENT.—All parts of the body are important to the butcher, for they represent the largest part of the dressed carcass. A broad, thick, strongly arched back; deep, smooth sides; and a trim, straight underline are the most important features to be desired. In scoring the several points here the student should ob-

serve the body from all sides—especially from behind and from the side. The most common faults in the average hog are a 'wasty' underline and heavy paunch, thin, narrow back, weak loin, and a lack of depth of fore and hind flanks.

Hindquarters—17 per cent.—The hams represent the largest part of the hind quarters. They should be viewed from both the side and rear, and the length, width, and thickness determined as accurately as possible. The hips of the fat hog are usually smoothly covered, but should usually be wider apart. This would insure a broader rump and thicker hams. When the legs and feet have been criticised, the scoring is completed, and the sum of the score will represent the student's estimate of the pig's merit or degree of perfection.

Comparative Judging.—After the student has had the practice of scoring several individuals, especially with an experienced judge, he is ready for the more practical work of placing a ring or class of fat hogs. Since the things which constitute merit in the packer or butcher's hog, as already indicated, are dressing percentage and quality of meat, only those important factors which determine these should be considered by the judge. The character of the hog, or the points of the score card, which bear an important relationship to these two qualities are all included by the general points of weight, form, covering and quality. In judging a class and discussing reasons for placing, therefore, it is best to observe these important essentials and dispense with the details as much as possible. *Weight, form, quality* and *covering* are, therefore, the conditions that should be emphasized in practical judging.

THE BROOD SOW

The most valuable brood sow is the one which regularly produces large, strong, uniform litters of pigs. In addition to regular and prolific breeding qualities, it is also important that she transmit to her pigs, quick, easy feeding traits and those qualities which indicate profit when sold. The brood sow herself must, therefore, first, be a good breeder, second, a good feeder, and third, represent the general form and quality demanded by the market. All breeders of lard hogs agree in attempting to produce these important essentials. As a result the principal breeds of lard hogs are similar in their general characters. Breed differences are due more to variations in color, set of ear and dish of face than to those things which determine the real usefulness of the sow.

In judging brood sows the following general plan may be followed to advantage in making the observations, attention being here given to those essentials common to all the lard breeds.

SIZE.—A good standard for a mature brood sow in strong, breeding condition is from 350 to 400 pounds. When carrying an excess of fat, as is common when fitted for show, they should exceed this weight. Sows of this size are thought to be most able to produce pigs which will combine the ability to grow rapidly with a tendency to fatten early. Sows that are extremely small are usually too fine, lack constitutional vigor, and produce pigs lacking thrift

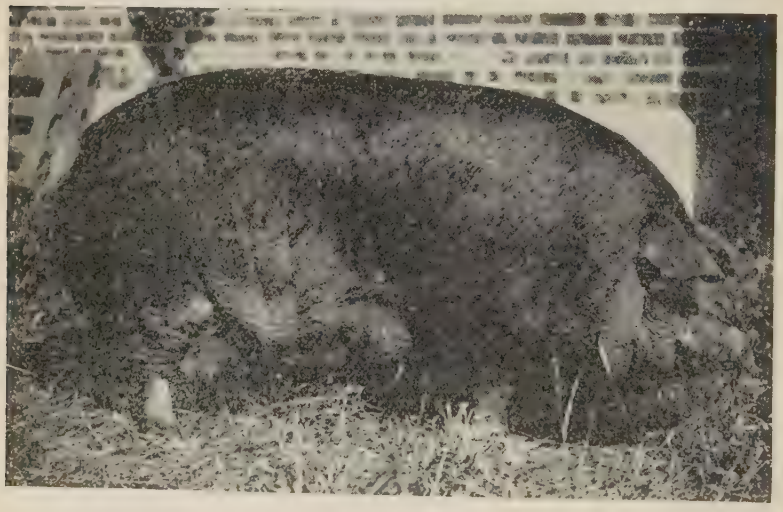


Photo by Hildebrand

Fig. 67. Unusual combination of size and substance with refinement and quality. Pure-bred, prize winning Duroc-Jersey sow

and growing qualities. On the other hand, sows of extreme size are usually coarse in quality and produce pigs lacking the smoothness and early maturity demanded by the market.

FORM.—The form or type of the brood sow should in general be similar to that of the finished fat hog. There are important differences, however, which should be observed. The brood sow should have more length, and because of thinner condition, should not have the same appearance of compactness and thickness which is shown in the fat hog. She should be deep bodied, broad and uniform in width, and roomy. Smooth shoulders, a strong, arched back, a wide loin, level rump, and deep, full sides are especially desirable. She

should be wide between the eyes and not long in the snout. Depth and width of chest and a roomy middle indicate strong constitution, superior feeding qualities, and, usually, ability to produce large litters. A full development of 12 teats is of the greatest importance.

The legs should be squarely placed, straight, and strong. A sow with weak pasterns, extremely light bone, and crooked feet and joints is objectionable as a breeder. It is very desirable that the sow have strong, upright pasterns. A medium sized bone of quality is to be preferred. It is even more necessary to shun light bone of too much fineness than it is bone which is too heavy and coarse.

Quality.—General smoothness, fine, straight hair, refinement about the head and ear, and clean, dense bone are all indicative of quality in the brood sow as in the fat barrow. Quality in the brood sow is usually associated with improved breeding and easy keeping qualities. It is also a guarantee of quality in the pigs. In judging brood sows, however, quality should not be insisted on to the extent of sacrificing sufficient size and substance of bone. Extreme refinement is undesirable. A good guide is to value quality so far as it results in general smoothness and increased strength and density of bone.

Femininity and Disposition.—Femininity is indicated by refinement about the head and face, a light neck, a roomy middle, well developed udder and teats and wide hips. Femininity is opposed to masculinity. It includes all of those things which indicate the female sex. The most feminine sows are usually free breeders and the best mothers.

The sow with the most pronounced femininity is apt to have the most desirable disposition, and will usually succeed in saving her pigs. The brood sow should have a gentle, active, vigorous disposition. A sow that is wild and nervous, or that naturally has a bad temper, is a pig killer. For the same reason the sluggish, lazy, awkward sow should be discriminated against.

In judging brood sows, therefore, we should consider primarily their *size*, *form* or *type*, *feet* and *legs*, *quality*, *femininity*, and *disposition*.

THE BOAR

The same general method employed for the examination of the brood sow may be followed in judging the boar.

Differences which exist in the standard for the boar as compared with that of the brood sow are the result of differences in sex. Femininity in the sow should give place to pronounced mascu-

linity in the boar. The boar which has a weak, feminine, or staggy appearance about the head is usually not able to impress his own characters upon his offspring.

As compared with the sow the boar is heavier and stronger in appearance about the head, neck and shoulders. Refinement and femininity of the sow should give place to strength and masculinity in the boar. It is characteristic of the boar, also, to be shorter bodied and more compact than the sow. This appearance of compactness and strength in the boar is aided by the development of shields on the shoulder sides with approaching maturity.



Photo by Hildebrand

Fig. 68. The extreme lard hog type. Pure-bred Poland China boar in show condition

The boar should *weigh,* on the average, from 75 to 100 pounds more than the sow when in the same degree of flesh. A boar of rather the medium weight for the breed will usually prove the most satisfactory breeder. Extreme size is apt to be associated with undue coarseness or lack of quality.

The *form* of the boar should indicate a strong, vigorous constitution and good feeding qualities. As with the sow, it is especially desirable that the boar be wide between the eyes, wide and full in the chest, and strong in the back and loin. A level rump, full hams, straight sides, and low flanks are essential and add to his appearance of symmetry.

Feet and Legs.—He should have plenty of bone, and stand wide and straight. It is very important that he be strong in the hocks, for when breeding, much strain is borne by these parts, Medium-sized bone with quality is to be preferred to either fine bone or extreme size of bone.

Quality.—This is of the same value in the boar as in the sow. The indications of quality are the same in both. The boar, however, because of his heavier shoulders and masculine character, should not be expected to show the same degree of refinement as



Photo by Hildebrand

Fig. 69. The bacon type. Pure-bred Yorkshire boar

the sow. General smoothness of form and covering, fine, straight hair, and clean, hard bone are the important indications of quality.

Disposition.—In judging boars the importance of an active, vigorous dispositon should not be overlooked. For this reason the boar should be made to move about and his ease and freedom of action observed. A boar that is weak on his feet and legs is an unsafe investment for the breeder and should be discriminated against.

Weight, form, feet and *legs, quality, masculinity,* and *disposition* are the important general points to be observed when judging the boar.

PART VI

JUDGING SHEEP

H. E. Allen, Assistant Professor of Animal Husbandry

INTRODUCTION

In taking up the study of sheep judging the first thing to do is to become familiar with the names and location of the various parts of the animal's anatomy. This is necessary in order that the descriptions of the parts and the instructions as to how to go about their examination may be readily understood. Make a thorough study of the Figs. 73 and 74 on page 92 until the points of the sheep are well in mind before trying to do any scoring or judging.

CLASSIFICATION OF SHEEP

After getting the points of the sheep clearly in mind the next thing to consider is the classification. It is necessary to become familiar with these classifications before you can judge sheep according to their utility and merit. Two classifications are given: first, grouping them according to types and breeds; and second, according to how they are sold on the market.

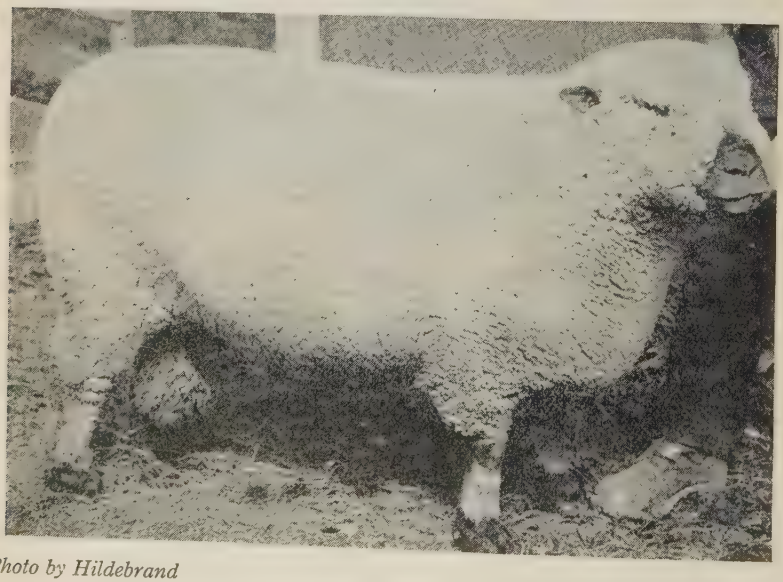


Photo by Hildebrand

Fig. 70. A good mutton, medium wool type. Shropshire ram



Photo by Hildebrand

Fig. 71. A good mutton, long wool type. Lincoln ram



Fig. 72. A good fine wool type. Rambouillet ram

Classification No. 1 *Types*	Mutton	Medium wools or Down breeds (8 breeds)
		Long wools (3 breeds)
	Merino—Fine wools (3 breeds)	

The names and a brief description of the breeds that belong to the various sub-types are given in a table on page 124 of this circular.

Two General Types.—The above classification divides all sheep into two general types on the basis of the purpose for which they are bred. The breeders of the mutton type breed primarily for mutton, with the fleece as a secondary consideration.

The breeders of the Merino or fine-wool type emphasize first of all the wool producing qualities with mutton production as of secondary importance. The ultimate result has been a wide difference in the make-up of the two types which from the judging standpoint must be considered separately.

By the above classification note that the mutton type of sheep is divided into two sub-types or groups, medium wools and long wools. This division is made on the basis of the nature and length of the wool and not on the basis of conformation or utility. Although the breeds within these two groups differ materially in character, what is known as the mutton type or form is essentially the same in both groups and the advocates of each breed have the same ideas as to what constitutes good form, quality, and constitution regardless of the breed to which the animal belongs. In these essentials of the mutton sheep, breeders of the several mutton breeds have many things in common and all agree on a common ideal in most respects.

The market cares nothing for breed characters and it never asks to what breed the animal belongs. However, some markets do prefer the black faced type. What it demands is the best development of those parts which make for good mutton. As a result sheep that go on the market are not classified with respect to breed type. They are classified on the basis of their utility according to the following outline:

Classification No. 2 *Market Classes*	Fat or mutton	Lambs Yearlings Wethers Ewes Bucks or stags
	Feeder	Lambs Yearlings Wethers Ewes
	Breeding	Ewes Bucks

By *market* sheep is meant all those sheep that are sold on the live stock market. The names of the classes indicate the use to which they are put, while the names of the sub-classes suggest difference of either age or sex between sheep put to the same use.

After the parts of the sheep, and the classifications according to breed types and market demands are clearly in mind, you are ready to proceed with the scoring and judging.

According to classification No. 2, market sheep are divided into three classes,—*fat, feeder,* and *breeding,* according to the use to which they are put when sold.

FAT SHEEP

Market Demands.—It is the ultimate aim of all breeders of mutton sheep to produce that type best suited to fill the demands of the butcher. The main feature demanded in a sheep by dealers in high-class mutton are, proper *age* and *weight, form, condition,* and *quality.* Each of these features will now be taken up separately and discussed. These discussions will aim to give instructions on (a) what constitutes the ideal; (b) how to examine the parts to determine how nearly they approach the ideal; and, (c) some of the more common faults or defects that are often present and should be discounted in determining the true merit of the individual. Therefore, we will first take up a detailed description of that type and in connection with this give directions as to the best method of examination to secure a definite idea whether or not the animal fulfills all the requirements of the fat sheep as indicated in the butcher's or market's ideal. This ideal is best represented in the score card, page 93.





Figs. 73 and 74. Points of the sheep

1. Muzzle	6. Face	11. Shoulder vein	16. Fore leg	21. Fore flank	26. Crops		
2. Mouth	7. Forehead	12. Top of shoulder	17. Back	22. Belly	27. Dock or tail		
3. Nostril	8. Eye	13. Shoulder	18. Loin	23. Flank	28. Twist		
4. Lips	9. Ear	14. Chest	19. Hip	24. Rump	29. Hind leg		
5. Nose	10. Neck	15. Brisket	20. Ribs or side	25. Leg of mutton or thigh			

SCORE CARD

MUTTON SHEEP **FAT**

SCALE OF POINTS	Standard	Points deficient	
		Student's score	Corrected
1. Age			
GENERAL APPEARANCE—38 per cent.			
2. Weight, score according to age	8		
3. Form, long, level, deep, broad, low set, stylish	10		
4. Quality, clean bone; silky hair; fine, pink skin; light in offal, yielding high percentage of meat	10		
5. Condition, deep even covering of firm flesh, especially in regions of valuable cuts. Points indicating ripeness are, thick dock, back thickly covered with flesh, thick neck, full purse, full flank, plump breast	10		
HEAD AND NECK—7 per cent.			
6. Muzzle, fine; mouth large; lips thin; nostrils large and open	1		
7. Eyes, large, clear, placid	1		
8. Face, short; features clean-cut	1		
9. Forehead, broad, full	1		
10. Ears, fine, alert	1		
11. Neck, thick, short, free from folds	2		
FOREQUARTERS—7 per cent.			
12. Shoulders, covered with flesh, compact on top, snug	5		
13. Brisket, neat, proportionate; breast wide	1		
14. Legs, straight, short, wide apart, strong; forearm full; shank smooth, fine	1		
BODY—20 per cent.			
15. Chest, wide, deep, full	4		
16. Ribs, well sprung, long, close	4		
17. Back, broad, straight, long, thickly fleshed	6		
18. Loin, thick, broad, long	6		
HINDQUARTERS—16 per cent.			
19. Hips, far apart, level, smooth	2		
20. Rump, long, level, wide to tail-head	4		
21. Thighs, full, deep, wide	4		
22. Twist, plump, deep	5		
23. Legs, straight, short, strong; shank fine, smooth	1		
WOOL—12 per cent.			
24. Quantity, long, dense, even	4		
25. Quality, fine, pure; crimp close, regular, even	4		
26. Condition, bright, sound, clean, soft, light	4		
Total	100		

Study the score card and use it in the scoring of several animals until you become familiar will all its parts and the relation they bear to each other and to the live sheep.

Method of Examination.—On account of the length of the fleece it will be necessary to carefully handle every part of the sheep to determine its form, quality, and condition. Moreover, all exhibitors practice trimming to give their animals a smoother and more attractive appearance than they would have otherwise and thereby are able to cover up many defects of form, and, in case the wool is long enough, can give their sheep almost any shape desired. Fig.



Fig. 75. Noting general appearance and breed type

76 illustrates a ram lamb before trimming and Fig. 77 the same lamb after trimming.

These illustrations suggest the necessity of careful handling, and demonstrate the fact that sheep judging is a very different proposition from the judging of other classes of live stock, in that the hands and not the eyes must be depended upon, thus necessitating a different method of examination.

It is all the more important, then, that a definite plan of procedure be adopted in order that no part be overlooked and that no defect escape notice. Note in all the figures illustrating the manner in which a judge should handle a part, that when examining

it, he holds his hands flat with the fingers together in a sloping manner. In this way it is possible to feel the form of the sheep without disturbing or breaking the fleece. Sticking the fingers into the fleece makes holes in it, which gives access to rain and dirt, detracts from its appearance, and greatly annoys the shepherd.

The examination should be begun at the head and continued over the whole body. Figures which follow illustrate the position of the judge and the proper method of handling a sheep when judging.

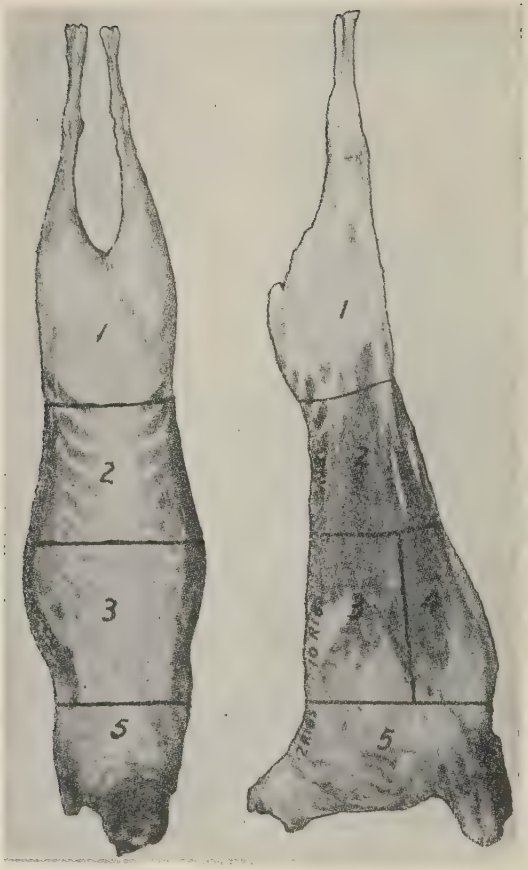
Age and Weight—8 per cent.—The lamb age is the most desirable age for butcher sheep due to the fact that it is the most profitable for the producer and is in greatest demand by the consumer. About 80 per cent. of all sheep marketed are lambs. Sheep pass from the lamb state just after they are a year old.





Figs. 76 and 77. Ram lamb before and after trimming. The general appearance may be improved by a judicious use of the shears

The age of a sheep is best estimated by the order of the appearance of the front teeth, called "nippers" or incisors. Sheep have eight permanent incisors in the lower jaw, having none in the upper. By permanent teeth we mean those that replace the baby, temporary, or milk teeth. The milk teeth can easily be distinguished from the permanent ones in that they are narrow, while the permanent incisors are broad and wide, widening out considerably toward the top. The permanent teeth take the place of the temporary in regular order by pairs as the sheep grows older. The first pair consisting of the two front teeth, one on either side of the medium line of the jaw supplants the milk teeth when the sheep is slightly over one year old. The next pair, that is, one on each side of the central or first pair, appears one year later or when the sheep is two years old; the third pair appears when the sheep is a little



Bulletin No. 147, Illinois Experiment Station

Fig. 78. Mutton and lamb cuts

1, 2.	Saddle	1.	Leg	4.	Breast
3, 4, 5.	Rack	2.	Loin	5.	Chuck
1, 2, 3.	Long saddle	3.	Short rack	4, 5.	Stew

over three years or between the ages of three and four; and the fourth pair, when the sheep is between four and five years old. Every judge should familiarize himself with the age of an animal as determined by its teeth, so that he will be better able to pass on other parts more or less dependent on age.

To estimate the age, observe the teeth by holding the sheep with the hand under the jaw and pressing down the lower lip with the thumb and forefinger.



Fig. 79. Mutton cuts located on a live sheep

1, 2. Saddle	1. Leg	4. Breast
3, 4, 5. Rack	2. Loin	5. Chuck
1, 2, 3. Long saddle	3. Short rack	4, 5. Stew

Lambs weighing about 80 pounds, in prime quality and condition, sell at the highest prices on the market. They should reach this weight at as early an age as possible. Mature wethers should weigh 140 pounds or more. Weight varies depending on various conditions, but is principally influenced by age, breed, and degree of fatness. Plenty of weight is desired to insure healthy, vigorous, and early maturing qualities, but too great weight is objectionable, in that it is likely to be associated with coarseness, and low dressing percentage, and also giving too large cuts for the retail meat trade.

FORM—10 PER CENT.—To form a basis for estimating the good and bad qualities of a fat sheep or lamb, it is best to consider the carcass from the point of view of the butcher. The different parts of the animal show a wide variation from the butcher's standpoint.

Fig. 78 shows the names and location of the wholesale cuts of meat on the dressed carcasses, and Fig. 79 shows the same thing on the live sheep. The accompanying table gives the per cent. weight of the dressed carcass, the wholesale price per pound, and the per cent. value of the dressed carcass that each wholesale cut represents.

WHOLESALE MUTTON AND LAMB CUTS

Mutton and lamb cuts	Names of wholesale cuts	Per cent. weight of carcass	Wholesale price per pound	Per cent. value of carcass
Saddle	Legs	30.36	13¼ cts.	43.16
	Loin	21.43	8¾ cts.	18.97
Rack	Hotel or short rack (10 ribs)	14.28	12¾ cts.	18.76
	Stew (chuck and breast)	33.93	5¾ cts.	19.11

A study of the above table and Figs. 78 and 79 will show that the most valuable meat is found on the hindquarters and loin. The butcher, therefore, requires in the mutton carcass a heavily fleshed leg of mutton, a broad back and a broad, full loin deeply covered with flesh, in order to secure the greatest percentage of valuable cuts. However, there is always a close correlation between all the parts of an animal and in order to secure high development in the desired regions a relatively high degree of development must be had in all parts. In general, then, the sort that are not too heavy boned, that do not have too large frames, and that do not show a tendency to be paunchy, but present a smooth, even, plump appearance, of the broad, low-set, thick type with special development of the leg, back, and loin, possess the form most desired by the butcher because they carry the least amount of waste and so dress out a higher per cent. of carcass to offal. In general appearance then the animal should present a general fullness and smoothness of outline, both of which indicate the desired thickness and evenness of flesh. A flat ribbed, narrow chested, drooping rumped, up-standing individual with peaked hindquarters, should be discriminated against, because such will carry a large amount of waste in proportion to the valuable cuts. Openness at the top of the shoulder, roughness, and angularity invariably go with bareness of shoulder, back, and loin, a thin leg of mutton and an excess of bone in the carcass.

Head and Neck—7 per cent.—The head should be short and broad, showing character. The eyes should be bright, full and placid, indicating a quiet disposition.

The muzzle should be large with open nostrils and strong lips, showing thrift and feeding capacity. The ears should be medium sized and covered with fine soft hair. Although the neck is a cheap part, it should be short and thick, which feature is likely to characterize the entire carcass.

To examine the neck, place both hands on either side as represented in Fig. 81 and note its fullness, length, and manner of blending into the shoulder at the shoulder vein.



Fig. 80. Typical mutton head. Notice breadth and shortness; large muzzle, open nostrils, large placid eyes, and fine ears

A long narrow head with a pinched muzzle and a thin neck are undesirable, because they indicate weakness of constitution and lack of thrift, and a thin neck usually goes with a slender body.

Forequarters—7 per cent.—Although the forequarters, consisting of the shoulder, brisket, and legs represent a small part of the value of a mutton sheep, yet a proper development of these parts is essential to give the required smoothness of form that goes with the best type of fat sheep. The shoulders should be smooth, well laid in at the top and evenly covered with flesh and well filled out in the crops and shoulder vein. The brisket should project forward and present a wide, full breast indicating health and vigor. The legs should be short, straight and set wide apart with a broad and well fleshed arm, the whole showing as little waste as possible.

With the hands on either side of the shoulders an idea of their width and covering can be obtained. The fullness of the crops and



Fig. 81. Examine the neck, noting fullness, shortness, and smoothness of blending into the head and shoulder



Fig. 82. Note the depth of chest, and with the left hand feel the width of the floor of the chest

shoulder vein may also be noted. The position to take to judge this part is indicated in Fig. 83.

A rough, bare shoulder indicates lack of quality and a large amount of waste, while narrow shoulders, and long, crooked legs, indicate low vitality and poor fleshing qualities.

Body—20 per cent.—The body is an important region in that it contains some of the highest priced meat along the back and on the ribs, and also contains the vital organs as the lungs, heart and digestive organs. You should look for a deep, full chest and a large heart girth because these indicate an abundance of heart and lung capacity. A narrow, shallow chested individual is almost sure to be low in condition and lack thickness of flesh. The back should not only be straight and strong, but covered thickly with firm, smooth flesh with the spinal column well hidden. A rough, open shoulder is usually accompanied by a narrow, weak, bare back. The ribs should be well sprung, giving ample space for the laying on of flesh. Flat ribbed animals are to be avoided in that they give a small amount of the high priced meat included in the short rack. A broad, thick loin is desired in order to be in keeping with the back and ribs and give a good connection between the heavily developed hindquarters or leg of mutton and the short rack, as well as to furnish a large amount of relatively high priced meat.

Weak, short, thin loins are found in up-standing, angular individuals, lacking depth of flesh in all parts of the body.

Hindquarters—16 per cent.—The hindquarters, consisting of the hips, rump, thigh, twist and legs constitute the wholesale mutton cut known as the leg of mutton. The value of this part to the butcher has already been emphasized by pointing out the fact that it represents over 43 per cent. of the value of the carcass, and it will be readily understood why an individual must show superior development in this region in order to meet with favor. The hindquarters should be long and continue straight and full both on the top and side lines. Drooping rumps are frequently seen and are most undesirable whether the falling away is toward the tail-head or down the thighs. The sheep should be especially strong from the hip to the hock. Not only should the leg of mutton be plump and full with flesh on the outside, but between the legs, in the twist, the flesh should fill well down to the hock, compelling the legs to stand well apart. When grasping the leg of mutton, a decided plumpness should be found.

Thin fleshed legs on the outside and a high, undeveloped twist often occur, giving the animal a leggy, narrow appearance behind. Such are undesirable because they indicate lack of constitution and



Fig. 83. Note width of chest, covering and smoothness of shoulders, fullness of the crops, and size of heart girth



Fig 84. Feel top of the shoulder for compactness. Moving the hand back in a flat position, note strength and straightness of top line to end of body, and evenness, thickness, and firmness of fleshing



Fig. 85. Judge width, length, thickness and firmness of flesh of loin

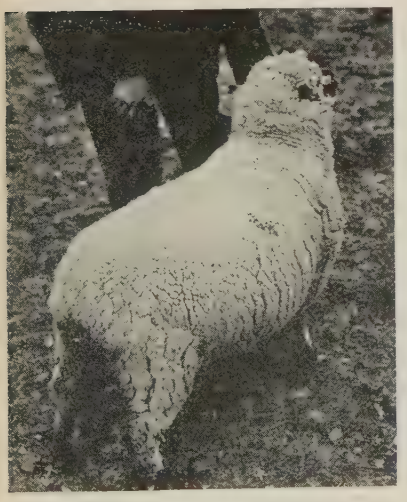


Fig. 86. Before shearing, the hand must be used to judge



Fig. 87. After shearing, the eye may judge

Note well sprung ribs, straight top line carried level to end of body, full twist, and well developed leg of mutton. A case where clipping could hide no defects



Fig. 88. With one hand at the hip joint and the other at the tail-head, note the length of the hind quarter



Fig. 89. At the thighs, note the degree to which the width is carried to the end of the body, and the depth and firmness of flesh on the outside of the leg of mutton



Fig. 90. Grasping the leg of mutton with both hands well up, note thickness and firmness of fleshing, and lowness and breadth of the twist



Fig. 91. Well developed hindquarters, broad, full twist, and thick leg of mutton. Winter or "hot-house" lambs ready for slaughter at three months of age; average dressed weight, 35 pounds. Spring of 1911, Purdue

represent such a large proportion of the carcass that its value to the butcher must necessarily be low.

Condition or Finish—10 per cent.—The terms quality and condition are frequently used interchangeably when used in connection with fat sheep because the quality of flesh is largely dependent upon condition. By condition is meant the degree of fatness and there are five reasons why the butcher demands that animals be fat: (1) other things being equal, the animal will dress a higher per cent. of edible meat to offal than in a half fat or thin animal; (2) fat adds to the appearance of the meat thus making it more salable; (3) fat carcasses will lose less in weight when cooling out



Fig. 92. Fat lambs finished for market, showing high condition and fine quality (Lot from Purdue feeding experiment 1910-11)

in the refrigerator and in cooking; (4) the keeping and curing qualities of the fat carcass excel those of the thin carcass; (5) when a considerable amount of fat is distributed through the lean meat the edible qualities are improved making it more tender, juicy, and of better flavor.

High condition is indicated by a deep, even covering of firm flesh, epecially in the regions of the valuable cuts. Points showing ripeness and finish are a thick dock, a full, mellow purse, a well covered back-bone, thickness and smoothness on the back and shoulder, fullness at the neck and flanks, and a plump, well filled breast. Condition is a very important consideration and is probably emphasized by the butcher more than any other feature.

It is impossible to tell condition by merely looking at the sheep hence it is necessary to use the hands freely in examining the points above mentioned, in order to draw conclusions not only of the degree of fatness but also of the nature and quality of the flesh. The most desirable quality of flesh is indicated by firmness

along the back, at the loins, over the sides and at the leg of mutton. Many sheep men describe this firmness as being "hard as a board" but the novice must be careful that he does not mistake bareness or lack of flesh for this hardness. While the flesh should have that firmness which would impress an inexperienced man as being hard, it should have enough springiness to yield lightly to the touch. The flesh should extend well down over the sides, without softness due to excessive fat or oily tissue. Then too, very often, rough, blubbery patches will be present about the tail-head. These are very objectionable in that they are entirely waste and are usually associated with carcasses in which the fat and lean are not well marbled, thus giving low quality meat.

QUALITY—10 PER CENT.—Good quality is indicated by medium sized, lean, clean-cut head and ears; fine, dense bone of medium size; soft, silky hair on the face, ears, and legs; a fine, pink colored mellow skin or pelt; and a smooth, even covering of firm flesh. Quality is important because it is usually associated with good breeding and rapid fattening ability, and because the waste is always less from a sheep of good quality than it is from one of inferior quality. Lightness rather than heaviness of pelt is desired in fat sheep. By pelt is meant the skin and wool combined. To secure a pelt of light weight the skin should be thin and free from folds and wrinkles, and the wool should be abundant but not too oily. Quality is usually associated with style and "breeding" and is an evidence of refinement as opposed to coarseness and grossness, which in turn are objectionable because they represent a high degree of waste. Quality is very essential to the best mutton type, as indicated by the fact that it is given 10 per cent. on the score card.

Since the quality of the flesh and skin can only be determined by touch, it should be kept in mind at the same time the animal is being examined for form and condition. General quality which is indicated by the features of the head, the fineness of the hair and the density of the bone is determined by the eye.

Coarseness, grossness, and sluggishness which are indicated by a heavy, rough head, covered by coarse, harsh hair, and large, coarse ears; a thick, wrinkly skin covered with coarse wool; a large, open frame with heavy bone and rough joints, standing on long, crooked legs, and an uneven distribution of flesh, detract from the appearance and quality of the individual and should be discriminated against because they add to the waste or offal and materially detract from the value of the animal.

WOOL—12 PER CENT.—*Quantity.*—The factors which determine the quantity of the wool are length and density, and the evenness in both over all parts of the body.



Fig. 93. Manner and place of opening fleece to examine the densest and finest quality of wool. Note also color and condition of skin



Fig. 94. Manner and place of opening the fleece to examine the poorest quality of wool

Length is an important feature both from the commercial point of view and from the shepherd's standpoint. The manufacturer of woolen goods desires a short-stapled wool, for such has better felting qualities. On the other hand the manufacturer of worsted goods, desires length of staple because it gives a yarn of strong, even texture. Other things being equal, a long staple, will afford more protection to the sheep. By *density* is meant closeness of the fiber, or the number of fibers that grow on a square inch. A heavy fleece is secured by density and such a fleece affords greater protection to the sheep. Quantity is further increased by the fleece being of uniform length and density all over the body, avoiding uneven and bare points.

Quality.—The fleece should be fine, pure and soft, with a close, regular crimp, and should be of uniform quality all over. Quality and quantity are not usually found together in their highest state of development in the same types or breeds and the shorter fleeces are usually those that show the most quality. In order that high grade goods may be manufactured from wools, the fibers must be soft and fine and of uniform texture. By the crimp is meant the wave in the fiber. The crimp should be regular and close together, the finer quality fleeces usually having the closest crimp.

Condition.—By condition is meant the brightness of the fleece, and its healthy appearance. It should be clear, soft and light, being free from harshness and foreign matter such as dirt, burrs, and hairy fibers. The amount and character of the yolk, grease, or oil determines to a great extent, the condition. Too much yolk is not desired, but a sufficient amount is necessary to give the fleece a soft texture and a bright lustre, which are indicative of health. The skin beneath the wool should be of a bright pink color. A bluish tint is often found in the skin but should be discriminated against because it may indicate lack of vigor and health.

Comparative Judging.—The foregoing discussion has dealt almost exclusively with observations on and descriptions of the good and bad qualities of a single individual; also methods of examination of same. It has taken up the various features and considered them more or less in detail. It is essential to become familiar with all these details of an animal before a fair estimate of its true merit can be made. The work so far has been a study of the ideal and a detection of faults and deviations from the standard required. In other words, the work has consisted of accurate observations, which is an analysis of conformation, quality, condition, etc. In actual sheep judging, however, where several animals are brought together for the judge to rate and place, the judge must balance

these observations already made. This is altogether a matter of comparison and may be called *comparative judging.*

In the show ring, the judge must inspect each animal separately, then make a draft of the likely winners, by considering, balancing and comparing each of the main points separately and collectively, until he is able to decide which animal, on the average, comes most nearly to filling all the requirements of the standards for that class. Such animal will be the first prize winner, the next best will be the second prize winner, and so on until all the animals are placed relative to their respective merit.

In doing this work the judge keeps uppermost in mind the more important features of general appearance, style, size, and conformation, quality, condition, and wool, at the same time, keeping in mind that these features include collectively all details which he may consider if made necessary by the presence of evenly balanced animals in the ring.

FEEDER SHEEP

When judging *feeder* sheep, always keep in mind the type that best meets the demands of the butcher. The feeder that will come nearest to doing this when fat will be the most profitable.

Constitution and Form.—From the market standpoint the chest, breast, or underline requires little consideration but in the view of the feeder, these points are of great importance. To be profitable to the feeder, a sheep must have a vigorous constitution, be able to consume a large amount of feed and transform it into valuable meat at the lowest possible cost. These characters are invariably associated with a wide, deep chest, good depth of barrel, and well sprung ribs to give ample room for the lungs, heart, and digestive organs. Good size is desired because an animal is wanted that will attain a good weight at an early age. A short, broad head with fine quality ears, full, bright eyes, open nostrils, strong lips, and a short, thick neck, deep body and short legs, all indicate a vigorous, thrifty animal which will give a good return for feed consumed and kill out a valuable carcass of mutton when fat.

Quality.—Quality is indicated in the feeder in the same way that it is in fat sheep. It is very important in that it adds to the value of the carcass when fat, both in dressing per cent. and the edible quality of the meat. It is also very closely associated with the growth and feeding qualities of the animal.

Condition.—By no means should feeder sheep be fat. However, the better type shows fairly straight, full outlines because they indicate good growth and a rapid feeding tendency. Then too the very thin lamb is not likely to finish in a normal feeding period

and is less likely to possess the thrift and constitutional vigor necessary to make fast and economical gains in the feed lot. The animal that carries some flesh and is in a growthy condition is preferred, at the same price per pound, to the very thin animal because it will finish quicker and to a higher degree, even though the gains per day are not so great.

BREEDING SHEEP

All the marks of excellence in conformation, constitution, and quality, that are required in butcher and feeder sheep, are just as important in the breeding classes. Because of the action and workings of the law "like begets like" you cannot expect to raise high class feeders that will finish into high grade butcher sheep from an inferior lot of breeding stuff.

Besides the above mentioned requisites, special attention must be given to breed type and sex characters. Then too, greater emphasis must be placed on the character of the fleece, the color of the skin, and the constitutional vigor and thrift of breeding sheep, for without such qualities all excellence of form, quality, etc., will avail nothing if the animal is not strong enough to transmit these good features to its offspring. Straight, strong legs, set well apart, with strong pasterns, are also very necessary to the general health and utility for breeding purposes.

THE EWE.—When judging the ewe from the breeding standpoint it should be remembered that she must possess not only the requisites of the fat sheep in general form and quality, and the constitutional vigor and feeding and fleshing qualites of the feeder, but she must also possess all those characters that indicate a long-lived, regular, and prepotent breeder. To insure a long life and regularity in breeding, the ewe should be rugged in constitution, of good form, sound in mouth and udder, and bear an abundant fleece of healthy wool. In addition to this she should have a strong maternal nature and feminine appearance. This is indicated by rather fine features about the head, a slender neck as compared to that of the ram, especially deep, round ribs, with a rather long, capacious body to provide room for the developing fetus. The ewe that will milk well and rear early maturing lambs, tends towards the wedge shape, being deeper in the chest, larger bodied, and wider across the loin and hips than the ram. She should not carry excessive fat. The flesh should be firm and evenly distributed, and not gathered in blubbery patches about the tail-head.

Ewes should adhere very closely to the type of the breed to which they belong, possessing in a marked degree all the breed characters that are laid down in the standards of the breed association.

Such ewes give evidence of purity of breeding through several generations along definite lines for a definite purpose, having the breed characters so fixed as to be uniformly transmitted to the offspring.

Rough ewes with plain, heavy heads and necks, lacking in general refinement and feminine appearance are rarely satisfactory breeders. On the other hand, short, shallow bodied ewes with narrow hindquarters and an undersized, stunted appearance should also be avoided for they lack the necessary breeding essentials of size, form, quality and constitutional vigor as pointed out above.

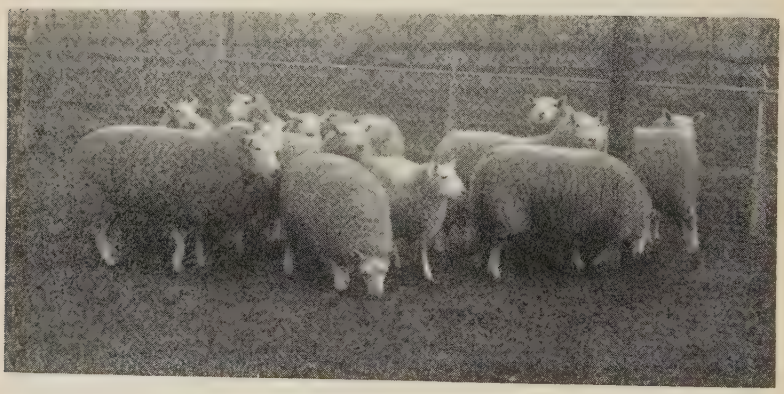


Photo by Lantz

Fig. 95. Note uniformity, close adherence to breed type, apparent thrift and constitutional vigor. Flock of Chevoit breeding sheep

THE RAM.—The ram is the head of the flock and might well be called half of it. Type and breed characters are the first considerations in judging a ram. He should be pure-bred and possess, to a high degree, all the characters of the breed to which he belongs, as in the case of the ewe, because this indicates prepotency. He should have plenty of size, and as opposed to the ewe, have a strongly developed forehand and a decidedly masculine appearance, indicated by general burliness of the head, thickness of neck, general massiveness, with a bold, energetic outlook, a bright, clear eye, much quality, and a brisk movement, denoting vim and vigor. He should have widely distended nostrils, a thick, heavy loin, twist and crops, broad, full chest and brisket, a level, strong back, hips well laid in, a straight, deep, level flank, and a fine, long, dense



Photo by Hildebrand

Fig. 96. Showing good breed type, mutton qualities, size and constitution. Cotswold ram and ewe

fleece of good quality. Such a ram will leave his impress indelibly on the offspring. An effeminate ram is a decided objection because he usually lacks prepotency and is rarely a sure and strong breeder.

THE MERINO OR FINE WOOL TYPE OF SHEEP

The purpose of the Merino or fine-wool sheep is essentially different from that of the mutton type. The former is bred almost exclusively for its wool while the latter is bred principally for mutton with the wool as a secondary consideration.

Form.—The general conformation of the Merino may be compared to that of dairy cattle. It lacks fullness of breast, breadth of back, and general thickness throughout with a leg of mutton that lacks fullness, and has rather long neck and legs. An angular, muscular development of the entire body prevails rather than the smoothness and heavy fleshing of the mutton type. However, the head is short and should be broad at the muzzle, with large nostrils; the nose short and inclined to be wrinkled, and somewhat Roman shaped in the ram. Horns occur on most males of the fine wool type and on the females of some breeds. They have a more or less cork screw shape and should have a waxy, dense texture denoting quality. The neck is rather long and thin in the ewe but should show decided strength and masculinity in the ram with more or less 'throatiness.' Although the shoulders are narrow they tend to be prominent with sharp withers. The breast and chest are narrow but should gain capacity by depth. Crooked legs coming together at the knees, with the toes spread out are objectionable, indicating

as they do a narrow chest. The body usually carries a narrow back and flat rib. The ribs should be long to give ample feeding and breeding capacity. The sheep is usually inclined to be droopy and narrow behind with a thin leg of mutton carrying a small amount of flesh. The head and neck, forequarters and body are given about the same rating on the score card for both the mutton and fine-wool types. However, the hindquarters are given only eight per cent. for the fine-wool type as compared to 16 per cent. or double the amount for the mutton. This is readily understood when we consider that it is in the leg that we get the greatest amount and the highest priced meat in the mutton type, and that meat is of little importance in fine-wools.



Photo by Hildebrand

Fig. 97. Showing excellent fine wool type. Delaine Merino ram and ewe

Wool.—Since the wool is the principal source of income from the Merino sheep, it must be given special consideration. It is the most important factor in the true Merino type. When judging a ring of fine-wools almost half the rating is based on the fleece. The score card gives the wool a value of 45 per cent. in the Merino as compared to only 12 per cent. in the mutton type. The wool of the Merino is shorter than in the mutton type, but is very thick over the entire body, carrying well down on the face and legs and is remarkably fine in quality, having a very close crimp and an exceedingly soft texture. The yolk is abundant and gives the sheep a dirty and oily appearance because it collects and holds dust and foreign particles. Many sheep of this type possess folds on the neck and shoulders, and in some cases they appear on the body and thighs, affording more area for the growth of the wool.

APPENDIX

A METHOD OF LIVE STOCK IMPROVEMENT

W. W. Smith

The quickest, cheapest, and surest method of live stock improvement is *up-grading*. By this is meant the mating of the common grade stock of the farm with a pure-bred sire. It is not practicable nor possible to replace all the live stock of the farms of Indiana with pure-breds, for less than two and one-half per cent. of the live stock of the state is registered. It is possible, however, and would be highly profitable, to replace all the grade, cross-bred, and scrub males which are being used as sires, with males which possess the breeding that will insure improvement.

Up-grading is economical because the sire mates with the entire female herd, while the influence of the female is limited to a few. The well-worn expression, "the sire is half the herd" is more than true. The influence of the sire extends to all the offspring produced. Since the sire is pure in breeding, the young will resemble the sire more than the dam; i. e., the pure-bred sire is prepotent over the dam. It requires nearly as much feed to keep a poor animal as it does a good one. The annual cost of maintenance is practically the same. The greater cost of the pure-bred sire over the scrub is more than returned by the increased market value of his first crop of offspring.

The rate of improvement in up-grading is rapid and certain. The first cross with a pure-bred sire produces an animal that is one-half pure. When this animal is mated with a pure-bred sire the offspring is three-fourths pure. The third cross produces a seven-eights pure-bred, or a very high grade, and the next, an animal which is fifteen-sixteenths pure. For market purposes, the high grade is practically the equal of the pure-bred. Though good in individuality, he, however, is unreliable as a sire. The problems of live stock improvement very largely center upon the selection of the sire.

SELECTING THE SIRE

Since the sire must be largely depended upon as the source of improved breeding, his selection should be intelligently and carefully considered. Since his influence is equal to the influence of the entire female herd or flock taken collectively, his selection is the most vital consideration of live stock improvement.

PERFORMANCE.—The *first* essential of the sire is that he possess the ability to transmit his characters regularly and surely. It is the most fundamental quality of the sire. Due to the fact, also, that it is the most common and conspicuous weakness, it is of first importance.

The only reliable test of fertile, prepotent breeding powers is actual *performance*. The appearance of the sire as an individual, particularly his masculinity and vigor of disposition, and the character of the animals in his pedigree, are considered as general indications of breeding ability, but they should never be relied upon when the actual performance record is available. For this reason tested sires are much more reliable than sires of immature age. A fuller appreciation of this fact on the part of the breeder will not only prevent further sacrifice of promising sires just approaching the period of their greatest usefulness, but will greatly conserve and extend the service of those sires whose breeding qualities have been demonstrated. In buying a sire, therefore, the character and uniformity of his get should be considered of first importance and the most reliable single guide to his future breeding powers. Performance is the only real test of value.

INDIVIDUALITY.—The *second* consideration in buying or selecting a sire is his *individuality*. He should be a good individual. By this we mean that he possess the size, form and quality which indicate strong constitution, thrifty growing and feeding capacity in the offspring, and in addition, insure the production of the sort of animal which sells best on the market. He should be strong in masculinity and vigorous in appearance, for many believe that they reflect fertile breeding powers and prepotency. The ultimate test, for example, of the beef sire for up-grading is the character of the market steers he is able to get; the ultimate test of the stallion is the serviceability and market value of the geldings which he produces. In addition to possessing these fundamental requirements, the pure-bred sire should possess the characters of the breed to which he belongs, such as size, pecularities of color, form, shape of head, and set of horn, etc., i. e., his breed type characters should be strongly represented. When typical of a breed, we have good reason to expect his breeding to be more desirable than that of the individual lacking the characters of a breed.

Individuality means everything about the animal which can be seen with the eye or felt with the hand. Individuality is entirely depended upon by the judge in placing a class of animals in the show ring. In buying a sire, however, we should not depend upon individuality alone, for sometimes individuals which are good enough to exhibit in the show ring prove disappointing as breeders.

"Like produces like" only within very wide limits, and so individuality should be supplemented, when possible, by performance and pedigree.

PEDIGREE.—The *third* essential of the pure-bred sire is that he have a good *pedigree*. A pedigree is simply the record of an animal's ancestry. Besides the names of the sire and dam, and grandsires and grandams, etc., it usually includes also the color and date of birth of each animal, and the names of the breeders. A pedigree in itself is not a guarantee of merit, for all pure-bred animals may have recorded pedigrees. The most important thing in studying a pedigree, is to learn of the merit of each animal as a breeder and as an individual appearing in the immediate ancestry. If the immediate parents were good individuals and the grandparents were uniformly good, we have good reason for calling it a good pedigree. If we add to this, good animals of the third and of the fourth generations we have a still stronger guarantee of merit. Uniformity of individuality in the pedigree usually means similarity of blood lines, and this usually means strong, prepotent breeding powers for the animal under consideration. The most essential feature of a good pedigree is good individuality in the immediate ancestry.

SUMMARY.—In buying a sire, therefore, *performance*, or actual breeding ability, should be considered of first importance. *Individuality* is second in importance and a most reliable guide to merit for persons unfamiliar with pedigrees, or when the animal is too young to have been tested. Thirdly, a knowledge of the individual should be supplemented by a knowledge of the *pedigree*. When good individuality is supported by a good pedigree we have the strongest possible guarantee of good performance.

TABULATIONS OF BREEDS OF LIVE STOCK

WEIGHTS OF MATURE ANIMALS IN SHOW CONDITION

HORSES

Breed	Type	Range of height in hands and weight in pounds	Uses	Origin	Registered by	Secretary	Address
Arabian	Saddle	14—14½	Riding	Arabia	The Arabian Horse Club of America	Henry K. Bush-Brown	Newburg, N. Y.
Thoroughbred	Saddle	14½—16½ 900—1050	Racing, hunting	England	The Jockey Club	W. H. Rowe	5th Ave. and 46th St., New York, N. Y.
American Saddler	Saddle	15-1½ ins.—15-2½ ins. 950—1050	Business and pleasure riding	United States	American Saddle Horse Breeders' Association	Roger H. Lillard	Lawrenceburg, Ky.
American Trotter	Light harness	15¼—15¾ 900—1150	Business and pleasure driving; racing	United States	American Trotting Register Association	W. H. Knight	355 Dearborn St., Chicago, Ill.
[1]Morgan	Light harness	14¾—15¾ 900—1150	Business and pleasure driving; racing	United States	American Morgan Register Association	T. E. Boyce	Middlebury, Vt.
Hackney	Heavy harness	15½—15¾ 1000—1200	Park driving	England	American Hackney Horse Society	Gurney C. Gue	308 W. 97th St., New York, N. Y.
French Coach	Heavy harness	15—16 1200—1350	Carriage driving	France	French Coach Horse Society of America	Duncan E. Willett	Oak Park, Ill.
German Coach	Heavy harness	16—16½ 1350—1450	Heavy carriage driving	Germany	German, Hanoverian and Oldenburg Coach Horse Association of America	J. Crouch	Lafayette, Ind.
Cleveland Bay	Heavy harness	16—16¾ 1200—1550	General utility	England	Cleveland Bay Society of America	R. P. Stericker	Oconomowoc, Wis.
Percheron	Draft	15½—17 1800—2300	Heavy hauling	France	Percheron Society of America	Wayne Dinsmore	Union Stock Yards, Chicago, Ill.
French Draft	Draft	15½—17 1800—2300	Heavy hauling	France	National French Draft Horse Association	C. E. Stubbs	Fairfield, Ia.

[1]Sometimes considered merely as a family of the American Trotter

HORSES (continued)

Breed	Type	Range of height in hands and weight in pounds	Uses	Origin	Registered by	Secretary	Address
Clydesdale	Draft	16—16½ 1800—2300	Heavy hauling	Scotland	The American Clydesdale Association	R. B. Ogilvie	Union Stock Yards, Chicago, Ill.
Shire	Draft	16—17 1800—2300	Heavy hauling	England	American Shire Horse Association	Chas. Burgess	Wenona, Ill.
Belgian	Draft	16—17 1600—2300	Heavy hauling	Belgium	The American Association of Importers and Breeders of Belgian Draft Horses	J. D. Connor, Jr.	Wabash, Ind.
Suffolk	Draft	16—17 1800—2000	Heavy hauling	England	The American Suffolk Horse Association	Alex. Galbraith	Janesville, Wis.
Welch	Pony	12½—15½	Riding, saddle or driving	Wales	Welch Pony and Cob Society of America	John Alexander	Aurora, Ill.
Shetland	Pony	9—11 300—400	Children's riding or driving	Shetland Isles	American Shetland Pony Club	Miss Julia M. Wade	Lafayette, Ind.

CATTLE

Breed	Type	Average Weight Bulls	Cows	Color	Origin	Registered by	Secretary	Address
Shorthorn	Beef dual purpose	2300	1800	White, red roan, or red and white spotted	England	American Shorthorn Breeders' Association	Roy G. Groves Acting Sec'y	Chicago, Ill.
Polled Durham	Beef dual purpose	2300	1800	White, red roan, or red and white spotted	United States	The Polled Durham Breeders' Association	J. M. Martz	Greenville, Ohio
Hereford	Beef	2225	1700	Red with white faces, crest, stockings and underline	England	American Hereford Cattle Breeders' Association	R. J. Kinzer	Kansas City, Mo.
Aberdeen Angus	Beef	2075	1550	Black	Scotland	American Aberdeen Angus Breeders' Association	Chas. Gray	817 Exchange Ave., Chicago, Ill.

CATTLE (continued)

Breed	Type	Average Weight Bulls	Cows	Color	Origin	Registered by	Secretary	Address
Galloway	Beef	1875	1425	Black	Scotland	American Galloway Breeders' Association	Robt. W. Brown	817 Exchange Ave., Chicago, Ill.
Jersey	Dairy	1300	900	Fawn and black; white markings allowed	Isle of Jersey	The American Jersey Cattle Club	R. M. Gow	324 West 23rd St., New York, N. Y.
Holstein-Friesian	Dairy	1950	1250	Black and white	Holland	The Holstein Friesian Association of America	Fred L. Houghton	Brattleboro, Vt.
Guernsey	Dairy	1500	1000	Fawn—white	Isle of Guernsey	American Guernsey Cattle Club	Wm. H. Caldwell	Peterboro, N. H.
Ayrshire	Dairy	1500	1000	Red, white and brown or spotted	Scotland	Ayrshire Breeders' Association	C. M. Winslow	Brandon, Vt.
Dutch Belted	Dairy	1500	1000	Black with white band	Holland	Dutch Belted Cattle Association of America	G. G. Gibbs	Marksboro, N. J.
Brown Swiss	Dairy	1800	1350	Brown and mouse	Switzerland	Brown Swiss Cattle Breeders' Association	Ira Inman	Beloit, Wis.
Red Polled	Dual purpose	2000	1250	Red	England	The Red Polled Cattle Club of America	H. A. Martin	Gotham, Wis.
Devon	Dual purpose	1800	1400	Red	England	American Devon Cattle Club	L. P. Sisson	Charlottesville, Va.

HOGS

Breed	Type	Color	Size	Origin	Registered by	Secretary	Address
Berkshire	Lard	Black with white points	Medium large	England	American Berkshire Association	Frank S. Springer	510 E. Monroe St., Springfield, Ill.
Poland China	Lard	Black with white points	Medium	Ohio	National Poland China Record Association	A. M. Brown	Winchester, Ind.
					Standard Poland China Record Association	Geo. F. Woodworth	Maryville, Mo.
					American Poland China Record	W. M. McFadden	Union Stock Yards Chicago, Ill.

HOGS (continued)

Breed	Type	Color	Size	Origin	Registered by	Secretary	Address
Duroc Jersey	Lard	Red	Large	New York Vermont Connecticut New Jersey	National Duroc Jersey Record Association	J. R. Pfander	Peoria, Ill.
					The American Duroc Jersey Record Association	T. P. Pearson	Thorntown, Ind.
Chester White	Lard	White	Large	Pennsylvania Ohio (O.I.C.)	Ohio Improved Chester White Swine Breeders' Association	J. C. Hiles	Cleveland, Ohio.
Cheshire	Lard	White	Medium small	New York	Cheshire Swine Breeders' Ass'n	Ed. S. Hill	Freeville, N. Y.
Victoria	Lard	White	Large medium	Indiana New York	Victoria Swine Breeders' Association		
Essex	Lard	Black	Small	England	American Essex Association	F. M. Strout	McLean, Ill.
Small Yorkshire	Lard	White	Small	England	The American Yorkshire Club	Harry G. Krum	White Bear Lake, Minn.
Suffolk	Lard	White	Small	England			
Large Yorkshire	Bacon	White	Large	England	The American Yorkshire Club	Harry G. Krum	White Bear Lake, Minn.
Tamworth	Bacon	Red	Large	England	American Tamworth Swine Record Association	E. N. Ball	Ann Arbor, Mich.
Hampshire	Bacon and lard	Black with white band at shoulders	Medium	Obscure	American Hampshire Swine Record Association	E. C. Stone	Armstrong, Ill.
Mule foot	Bacon and lard	Black	Small	Obscure	National Mulefoot Hog Record Association	W. H. Morris	Indianapolis, Ind.

SHEEP

Breed	Type	Wool	Average Weight Ram	Ewe	Color of points	Origin	Registered by	Secretary	Address
American Merino	Merino	Fine wool	150	100	White	United States	Vermont, New York and Ohio Merino Sheep Breeders' Association	Wesley Bishop	Delaware, Ohio
Delaine Merino	Merino	Fine wool	150	100	White	United States	National Delaine Merino Sheep Breeders' Association	J. B. Johnson	248 West Pike St., Canonsburg, Pa.
Rambouillet	Merino	Fine wool	185	155	White	France	American Rambouillet Sheep Breeders' Association	Dwight Lincoln	Milford Center, Ohio
Southdown	Mutton	Medium	175	135	Gray	England	American Southdown Breeders' Association	Frank S. Springer	Springfield, Ill.
Shropshire	Mutton	Medium	225	155	Dark brown	England	American Shropshire Registry Association	Miss Julia M. Wade	Lafayette, Ind.
Oxford	Mutton	Medium	325	200	Brown	England	American Oxford Down Record Association	W. A. Shafor	Hamilton, Ohio
Hampshire	Mutton	Medium	250	190	Dark brown	England	American Hampshire Sheep Association	Comfort A. Tyler	310 E. Chicago St., Coldwater, Mich.
Dorset—Horn	Mutton	Medium	225	165	White	England	Continental Dorset Club	Joseph E. Wing	Mechanicsburg, Ohio
Cheviot	Mutton	Medium	225	155	White	England and Scotland	American Cheviot Sheep Society	F. E. Dawley	Fayetteville, N. Y.
Tunis	Mutton	Medium	150	120	Tawny	Africa	American Tunis Sheep Breeders' Association	Chas. Roundtree	Crawfordsville, Ind.
Leicester	Mutton	Long	240	180	White	England	American Leicester Breeders' Association	A. J. Temple	Cameron, Ill.
Cotswold	Mutton	Long	265	215	White frequently spotted with gray	England	American Cotswold Registry Association	F. W. Harding	Waukesha, Wis.
Lincoln	Mutton	Long	350	275	White mottled	England	The National Lincoln Sheep Breeders' Association	Bert Smith	Charlotte, Mich.

AGE OF THE HORSE

R. A. Craig, Professor of Veterinary Science

In judging the age of a horse we depend on the changes that take place in the development and wear of the front, or more properly, the incisor teeth. In the colt these changes are the eruption of the milk or temporary teeth, and their replacement by the permanent teeth.

A colt of one year of age has a full set of temporary incisors, and at the end of the second year all of their table, or wearing surfaces, show marked wear. The next important change is the replacement of the middle pair, or pincers, by the permanent pincers. This occurs six months later, and when the colt is three years old the permanent pincers have pushed up to the same level as the other teeth in the row. The other incisors, the dividers and corner teeth, are replaced at yearly intervals. (See diagrams page 125) At the age of four years and six months the horse should have a full set of permanent incisors. In about six months from the time the permanent tooth first appears through the gums, it becomes fully developed, and it is not until the horse is five years old that the corner incisors are up and in wear.

After the horse has its full set of permanent teeth, the changes in the appearance of the teeth are due to a wearing away of the table surfaces and a pushing out of the teeth in order to maintain the length of their free portions or that part of the tooth visible above the gums. In over-shot and under-shot jaws, or the parrot mouth and lantern jaw, the teeth wear unevenly and it is difficult to determine the age of animals having these deformities. Variations in the hardness of the enamel and dentine (see diagrams) that form the teeth may cause them to show more or less than the average wear. The character of the food may also influence wear. For example, horses that graze on short sandy pastures wear their teeth rapidly. These variations in the wear due to the above conditions need not be taken into consideration. For all practical purposes a horse may be considered as old or as young as his teeth indicate.

The appearance and shape of the table surface (see diagram) vary from year to year, and the angle with which the upper and lower rows of incisors meet becomes more acute as the horse becomes older. The general changes in the table surfaces noted are a wearing away of the cups and central rings of enamel; the appearance of the dental star or cross-section of the pulp cavity; a shortening in their lateral diameters; and an increase in their diameters from before to behind. (see diagram)

In examining the teeth for the purpose of determining age, it is advisable to first separate the lips with the fingers and note the angle with which the teeth meet. The mouth should not be handled roughly, and it is advisable for beginners to examine the mouths of horses of known age, for it is only by such practical methods that a person can learn to determine the age of mature animals.

The following is a brief statement of the changes in the shape and appearance of the lower incisors. At six years of age all of the teeth show wear, but the wear is not marked in the corner teeth until the year following. The teeth of the eight year old horse show marked changes. The wearing surfaces are oval and leveled and the cups are narrow. In the nine year old horse, the table surfaces may be termed smooth. The cups are small and all of the teeth are round and oval in shape. From this time on there is a very noticeable increase in the obliquity of the teeth, and marked changes in the shape and appearance of the table surfaces. At twelve years of age the tables are round and the central enamel rings are close to the posterior borders. At 15 years of age, the pincers and dividers are triangular, and the dental star has taken on a definite shape and is present in all of the table surfaces. (See diagrams page 125)

Fig. 98. Diagram to show how the cup disappears and the dental star gradually appears with the wearing away of the tooth. Starting with a lower pincer tooth from a five year old mouth. Compare with the tables shown in Figs. 102, 103, 104 and 105

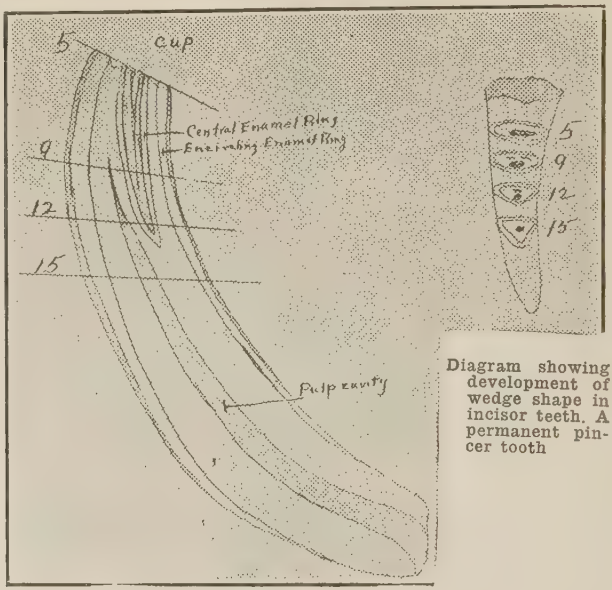


Diagram showing development of wedge shape in incisor teeth. A permanent pincer tooth

5—Table at five years. Cup in center of tooth. Not worn smooth. Large, and as seen from above, has the general shape of the tooth
9—Table at nine years. Cup present but worn. Dental star just appearing
12—Table at 12 years. Cup still present near posterior wall of the tooth. Dental star pronounced, at center of tooth
15—Table at 15 years. Cup entirely disappeared. Dental star pronounced in center of tooth
Pulp cavity appears on the table as dental star at about nine years

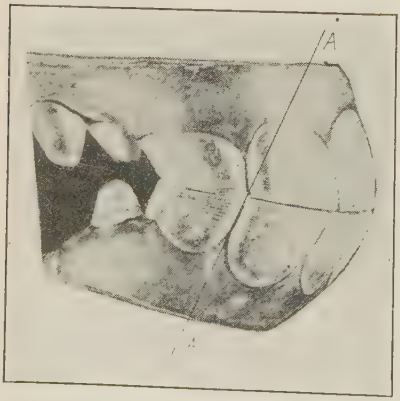


Fig. 99. Five-year-old. Note the upright direction of the line AA, denoting the slope of the teeth. Compare with the twenty-year-old mouth represented in next figure

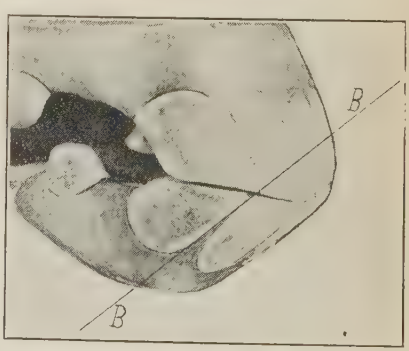


Fig. 100. Twenty-year-old. Note the slope of the line BB, denoting the slope of the teeth. Compare with the five-year-old mouth represented above. As the horse advances in age, the slope increases



Fig 101. Temporary incisors at two years. All free from the gum and in wear. AA, temporary pincers. BB, temporary dividers. CC, temporary corners

At two and one-half to three years AA, temporary pincers are dropped and DD, the permanent pincers come in

At three and one-half to four years BB, temporary dividers, are dropped, and EE, the permanent dividers, come in

At four and one-half to five years, CC, temporary corners, are dropped, and FF, the permanent corners come in



Fig. 102. Permanent lower incisors at five years. All permanent and in wear. DD, permanent pincers. EE, permanent dividers. FF, permanent corners

Note the size and shape of the cups. In the next three figures, note how the shape of the cup becomes more nearly circular, the position moves toward the posterior wall of the tooth, and how the cup finally disappears entirely at about 13 to 15 years of age. Note elongated shape of the tables, and in the following figures note how the shape of the tables change until they become triangular. Note reasons for these changes in Fig. 98



Fig. 103. Lower incisors at nine years. Note oval form of tables and of cups. Cup approaching posterior wall of tooth, and dental star appearing, as brown lines along the center of the tooth between the cup and the anterior wall. For reason for this see diagram in Fig. 98

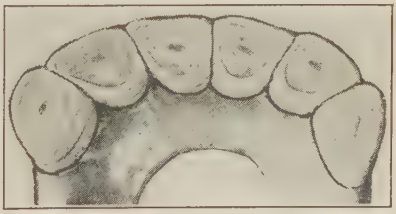
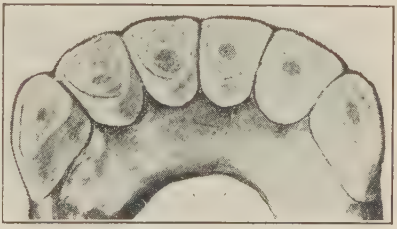


Fig. 104. Lower incisors at 12 years. Note triangular shape of tables. Cups appear as circular spots near posterior walls. Dental stars prominent at center of teeth

Fig. 105. Lower incisors at 15 years. Note marked decrease in lateral diameter of the teeth and commencement of triangular shape of tables. Cups entirely disappeared. Dental stars well marked at center of teeth



BOOKS ABOUT LIVE STOCK

Title	Author	Price
Types and Breeds of Farm Animals	Plumb	$2.00
The Study of Breeds	Shaw	1.50
How to Judge a Horse	Bach	1.00
Judging Live Stock	Craig	1.50
Farm Animals	Wilcox	2.00
Points of the Horse	Hayes	8.50
The Horse Book	Johnstone	2.00
The Horse	Roberts	1.25
Modern Sheep	"Shepherd Boy"	1.50
Sheep Management	Kleinheinz	1.50
Swine in America	Coburn	2.50
Farm Live Stock of Great Britain	Wallace	4.00
Breeding Farm Animals	Marshall	1.50

The above books are excellent aids to the study of live stock judging and breeding. There are other very estimable books on this subject. A long list, however, would only tend to confuse the person desiring information as to good books; therefore, the above are submitted with the remark that they are among the best contributions to the literature on this subject. Any of the above may be obtained postpaid from the Agricultural Extension Department of Purdue University upon receipt of price quoted.

BULLETINS ABOUT LIVE STOCK

The following are some of the bulletins which have been published treating of the types and breeds of farm animals, and methods of judging. Whenever available, they are an excellent source of information to the student.

Draft Horse Judging, Alexander, Wisconsin Experiment Station, Circular No. 17, Madison, Wis.

Improvement of Utah Horses, Caine, Utah Experiment Station, Bulletin No. 107, Logan, Utah.

Factors Influencing the Value and Cost of Feeders, Skinner and Cochel, Purdue Experiment Station, Circular No. 14, Lafayette, Ind.

The External Conformation of the Horse, Grange, Michigan Experiment Station, Bulletin No. 110, Lansing, Mich.

Market Classes and Grades of Cattle, Mumford, Illinois Experiment Station, Bulletin No. 78, Urbana, Ill.

Market Classes and Grades of Horses, Obrecht, Illinois Experiment Station, Bulletin No. 122.

Market Classes and Grades of Sheep, Coffey, Illinois Experiment Station, Bulletin No. 129.

Market Classes and Grades of Swine, Dietrich, Illinois Experiment Station, Bulletin No. 97.

Market Classes and Grades of Meat, Hall, Illinois Experiment Station, Bulletin No. 147.

Swine Husbandry, Critchfield, Pennsylvania Department of Agriculture, Bulletin No. 186, Harrisburg, Pa.

Practical Swine Management, Fuller and Alexander, Wisconsin Experiment Station, Bulletin No. 184, Madison, Wis.

The Score Card in Stock Breeding, Rommel, Bureau of Animal Industry, U. S. Dep't of Agriculture, Bulletin No. 76, Washington, D. C.

American Breeds of Beef Cattle, Rommel, Bureau of Animal Industry, U. S. Dep't of Agriculture, Bulletin No. 34, Washington, D. C.

Breeds of Dairy Cattle, Rommel, Bureau of Animal Industry, U. S. Dep't of Agriculture, Bulletin No. 106, Washington, D. C.

ACKNOWLEDGEMENTS

Acknowledgements for valuable assistance in this work are due as follows:

*Prof. C. N. Arnett, Iowa State College, Ames, Ia. Also for pictures 17 and 45, secured by him while abroad.

*Prof. H. P. Rusk, University of Illinois, Urbana, Ill.

*Prof. O. E. Reed, Kansas State College, Manhattan, Kansas.

Messrs. J. Crouch and Sons, Lafayette, Ind., pictures 3, 4, 5, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19 and 22, taken at Lafayette Stock Farm, where every possible courtesy was shown by the owners, Manager Hamer, and the grooms.

Mr. Jesse C. Andrew, Lafayette, Ind., pictures 82, 86, 87, 88, 90 and 94 taken at the Pines Shropshire Farm.

Dr. S. C. Lobdell, V. S., Lafayette, Ind., pictures 25, 26, 30, taken at his Veterinary Infirmary.

Mr. J. C. Allen, of the Animal Husbandry Department, Purdue, for the photographic work in connection with pictures 1, 2, 36, 38, 39, 40, 41, 42, 43, 65, 66, 73, 74, 76, 77, 79, 80, 92, 99, 100, 101, 102, 103, 104, 105 and 106.

Mr. Paul Roberts, of the Dairy Department, Purdue, for the photographic work in connection with pictures 48, 49, 50, 51, 52, 53, 54, 56, 60, 61, 62 and 63.

*Preliminary work on parts 2, 3, and 4, respectively, while at Purdue



Fig. 106. Judging beef cattle. Winter Course contest, Purdue University

PURDUE UNIVERSITY
Agricultural Experiment Station

Circular No. 30

LaFayette, Ind., October, 1911

AGRICULTURAL EXTENSION
XIII

COMMERCIAL APPLE GROWING

The possibilities for success in commercial apple growing in Indiana are as great as those possessed by any other locality.

In the undeveloped apple lands of Indiana the state possesses an agricultural resource of immense potential value, of which advantage should be taken at an early date.

Notwithstanding the excellent opportunities for success in commercial apple growing, Indiana is not now raising enough apples to supply the home demand. Indiana is a heavy buyer of apples. It should have apples to sell to less favored localities.

Indiana apple growers have an advantage of approximately $175 per car, over growers in the northwest, in freight rates alone for the transportation of their crops to the Chicago and New York markets.

Other conditions favorable to the development of commercial apple growing in Indiana are:—low priced fruit lands which are already producing apples of a quality second to none; accessibility of a large number of good markets; an under supplied home market; an increasing demand for the crop.

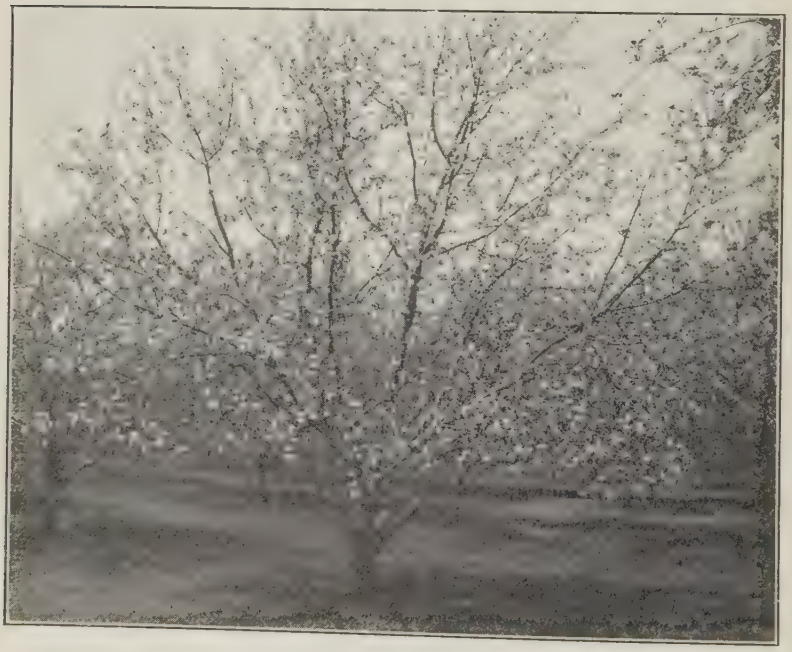
The fact that the apple has thrived in Indiana for a hundred years proves that the conditions are favorable. The fact is further proved by the experience of Indiana apple growers who are following up-to-date methods in the production of the crop. Profits of $100 per acre or more are not uncommon. One grower last season sold $3200 worth of fruit from two and one-half acres of 22-year old trees, making an estimated net profit of $960 per acre.

Many Indiana apple orchards have been allowed to fall into decline and many potential fruit growers have refrained from going into the business because it was thought to be an impossible or prohibitively costly and complex operation to protect the crop from its natural insect and fungous enemies. By modern meth-

ods, however, it is possible for the fruit grower to protect the crop with a great degree of effectiveness and at comparatively small cost.

The experiments carried on by the Station have proven that an investment of 15 to 20 cents per tree in spraying may increase the percentage of sound fruit from five per cent. on the unsprayed trees to 90 or 95 per cent. on those properly cared for. These results have been secured by inexperienced men at their first attempt. Experienced fruit growers expect and secure such results as a matter of course.

This circular discusses in detail the various problems of commercial apple growing as they appear in Indiana.



The promise of the apple harvest. Nature always does her part. In order to succeed or to deserve success, the apple grower must do his part likewise

COMMERCIAL APPLE GROWING

C. G. Woodbury W. M. Richards

It is the purpose of this circular to discuss the present status and possibilities of apple growing in Indiana, and to give such information as will be of most direct benefit to the prospective planter or the present owner of a commercial orchard.

I.—HISTORY AND PRESENT STATUS OF INDIANA APPLE GROWING

In general outline, the history of apple growing in Indiana is not unlike that of surrounding states. From the earliest years of the last century when Johnny Appleseed[1] made his plantings in the wilderness, it has been evident that the soil and climate of the state were adapted to this fruit.

The growing of apples, both for sale and for home use, was begun early. Henry Ward Beecher, writing from Indianapolis in 1843, says that at that time there were[2] "eighteen nurseries in the state whose proprietors are chiefly supported by their sales. Apple trees sell for 10 and pear for 20 cents. An orchard is to be found upon almost every farm and lately the pear has been more than ever sought after. * * * Long summers, brilliantly clear atmosphere, great warmth and dryness during the fall ripening months, give our fruit great size, color and flavor."

At the meeting of the Indiana Horticultural Society held in October, 1843,[3] among others of lesser amount, Mr. Z. S. Ragan exhibited 36, Mr. Sigerson 35, and Mr. Reuben Ragan and Mr. Aldridge each 31 varieties of apple as well as numerous varieties of other fruits. At the various meetings of the same organization held during the year 1844, 130 varieties of apples were exhibited.[4]

[1] An interesting account of this eccentric character, probably the first apple enthusiast in the middle west, is given by W. D. Holly in Harper's Magazine, Vol. 43, 1871. John Chapman (or Johnny Appleseed, as he was known among the early pioneers) was born probably in Boston in 1775. He traveled through the wilderness of Ohio and Indiana, planting apple seeds in favorable locations in the forests and along streams. These seeds he brought from the cider presses of western Pennsylvania. He considered it a sin to prune or graft. After Hull's surrender in the war of 1812, he saved many lives by warning the settlers of the approach of the Indians. Some of the trees from Johnny Appleseed's primitive nurseries survived until very recent years. He died in the home of a settler in Allen county, in 1847

[2] Magazine of Horticulture, Boston, 1843. Henry Ward Beecher was at that time resident in Indianapolis and was then and for several years thereafter corresponding secretary for the Indiana Horticultural Society. A reprint of the article appears in the Transactions of the Indiana Horticultural Society for 1910

[3] Transactions of the Indiana Horticultural Society for 1882; Transcript of the report of the meeting in 1843 as published in the "Farmer & Gardener," December, 1843

[4] Synopsis of proceedings for 1844, taken from the files of the "Western Cultivator" for 1845 and published in the Transactions of the Indiana Horticultural Society for 1882

In these early days, most of the pests which fruit growers must now contend with, had not appeared in the orchards with the devastating effect which is now so familiar. The San Jose scale was still safe in its native western Asia home; the codling moth, while known in the eastern orchards, had apparently not caught up with the westward march of the apple.[1] The virgin soil was undepleted of its stores of available plant food. Many of the fungous diseases had not in these pioneer times begun to infest the orchards as they infested them later. In many ways these first years were the most carefree years the apple grower has ever enjoyed in Indiana.

No sketch of the early history of Indiana apple growing, however fragmentary and incomplete, can omit the names of some of the pioneer horticulturists of the state. They were amateurs in the true sense; they loved their work with singleness of heart and they



Fig. 1. Young apple trees heeled in before setting. This should be done as soon as the trees are received from the nurseryman. Be sure that the soil is made firm about the roots

labored for the advancement of horticulture without having their eyes fixed too closely upon the dollar, as the immediate and sole reward of their endeavors.

[1] "For many years the cause of wormy apples in America was thought to be the plum curculio. Apparently it was not until 1819, that this mistake was discovered by breeding a moth from the supposed grubs of the curculio. At that time wormy apples and pears were common near Boston. By 1840 the insect had become a serious pest in the New England states and was common in central New York. A few hints here and there in the literature give us some idea of its westward progress. It is said to have been unknown in Illinois in 1849 and to have not invaded Iowa until about 1860. During the next decade its westward progress must have been rapid for it reached Utah soon after 1870 and appeared in California in the spring of 1874." M. V. Slingerland, Cornell University Agricultural Experiment Station, Bulletin No. 142, 1898

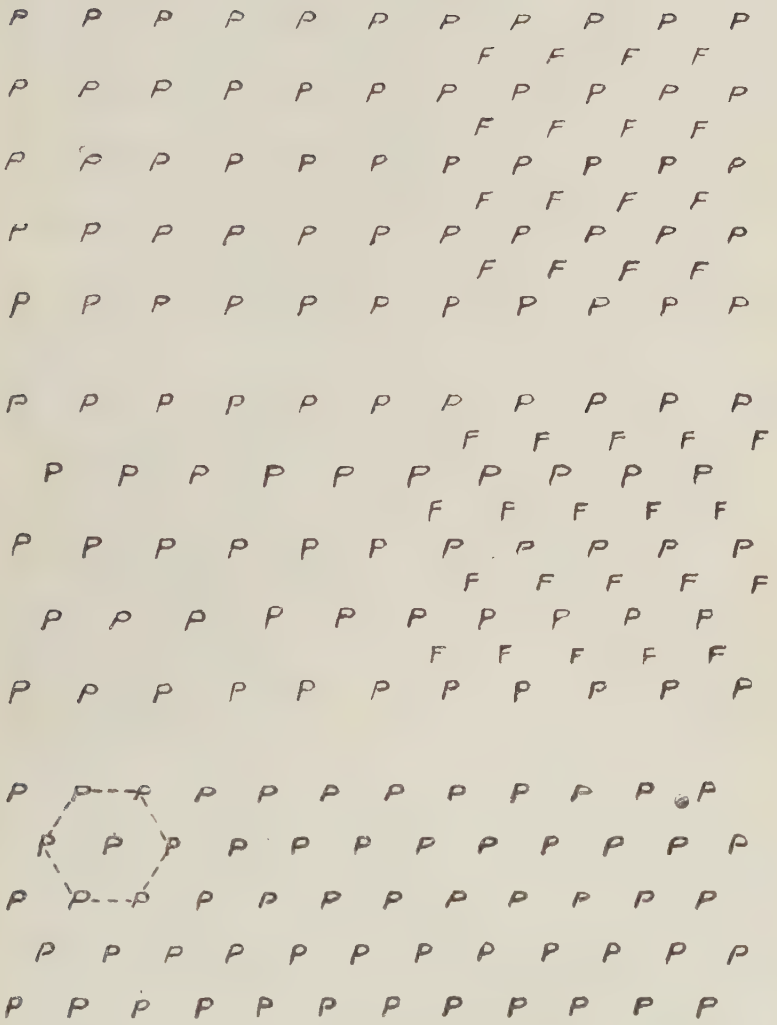


Fig. 2. Planting plans. Left at top, square plan; right at top, square plan with fillers (F) in centers of squares. Left in middle, alternate plan; similar to square except that rows are staggered. Right middle, alternate plan with fillers. Bottom, hexagonal plan; each tree equidistant from six surrounding trees

The names of the Ragans, of Teas and Fletcher and Warder[1] and a dozen of their fellows will always be remembered in connection with the early founding, the rapid spread and the abundant success of pioneer Indiana horticulture. Their fruits throve and multiplied.[2] These early apple growers tested and compared their varieties, and enjoyed their blessings with little thought of the spray pump, the fungus and the worm. Gradually the state began to

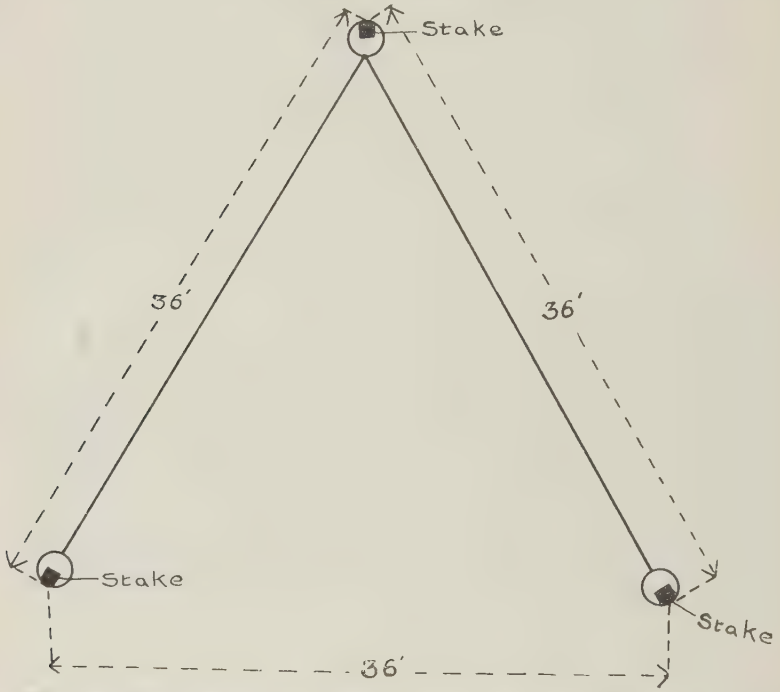


Fig. 3. This device, consisting of wires and rings is convenient in starting the laying out of the hexagonal plan of setting. The position of a third stake is quickly and accurately located from any two already set

[1] Dr. John A. Warder, physician and pioneer in pomology, geology and conservation, was a resident of Ohio rather than Indiana. He was the moving spirit, however, in the founding of the Indiana Horticultural Society and the inspiraton of his personality and the benefit of his judgment and advice were long enjoyed by the pioneer group who lived in Indiana

[2] In 1884, Daniel Bulla of Richmond said, referring to his father's orchard which was set in 1808 or 1809 and which was probably the first orchard in Wayne county, "The trees grew fast; were healthy. When they came into bearing, the fruit was large, smooth and perfect. I have seen the Maiden's Blush loaded with the largest and finest the country ever afforded. The apple crop was as sure as a corn crop is now." Transactions Indiana Horticultural Society, 1884

The Maiden Blush is now regarded as especially subject to apple scab. The scab was evidently not so plentiful then

emerge from its pioneer conditions. The forests were felled, more railways were built, highways improved; new settlers took up the remaining land, travel increased rapidly as the facilities for it were



Fig. 4. Newly planted two-year Rome Beauty tree before and after first pruning

perfected. Here was one set of causes at work to increase the insect and fungous pests of the apple orchard. The codling moth



Fig. 5. Newly set two-year Akin tree before and after first pruning. A bad crotch was prevented by the removal of one of the two leaders



Fig. 6. Showing height and development of heavy two-year Akin, before initial pruning; height and amount of wood left, and amount of wood removed in first pruning

and the curculio, unseen baggage, were carried along the same highways by which were transported from one section to another, the fruits they infested. As more home orchards were planted, and the distance from one orchard to another greatly diminished, the enemies of tree and fruit multiplied and found it possible to travel by easy stages from one part of the state to another, leaving in their path a trail of infested and disease ridden orchards. Some of these pests undoubtedly accompanied the increasing tide of migration from the older settled states of the east and some of them found in the new orchards acceptable substitutes for their former food plants in the vanishing forests.

The very abundance of the material resources of the state has perhaps proved a hindrance to the more rapid development of commercial apple growing. The would-be apple grower has not been dependent on that crop for his livelihood. At the first signs of failure, with the earliest indication of increasing disease and consequent uncertainty of crop, the fruit farmer of a generation ago found it easy to change his plan, and grow corn and wheat and live stock instead of apples. The old orchard, ceasing to produce spontaneously large and regular crops of perfect fruit was allowed to fall into a grievous decline. It was not cut down for it still occasionally, though with increasing irregularity, bore crops of fruit which, though far from perfect, were yet salable for cash; and so it has stood, a picture of ruin and a breeding place for orchard pests of every description, engaged in a more and more unequal contest with neglect. This very abundance of farming opportunity has thus, in the past, largely taken away the incentive for study and effort to produce perfect apples, that there would have been in a state not endowed by nature with such abundant and varied resources.

Furthermore, our earlier apple growers, however enthusiastic as pomologists, did not know how to control the pests which attacked their crops with ever increasing severity. They had no sources of expert information at hand. The sciences of entomology and plant pathology, upon which modern fruit growing so largely depends, were still in their infancy and detailed and accurate knowledge was not at their command if they had looked for it.

At length there came a change in conditions, gradual in reality, sudden in retrospect. The pear and apple orchards suffered from fire blight; the codling worm and the curculio multiplied unchecked; the scab, the various rots and other fungous diseases reduced the crop in both quantity and quality and many of the once profitable orchards were practically abandoned except for an occasional year of excessive production. The fruit was then perhaps harvested, but owing to its poor quality found a slow sale on a heavily supplied market.

In the reports of the Indiana Horticultural Society of 30 to 35 years ago, such statements from district vice-presidents as follows are not uncommon, [1] "Apples were abundant this year, but insects caused fully one half to fall prematurely and those picked for winter use have decayed badly, so that now our market is nearly bare of home grown apples and we must get our supply from the north or go without."

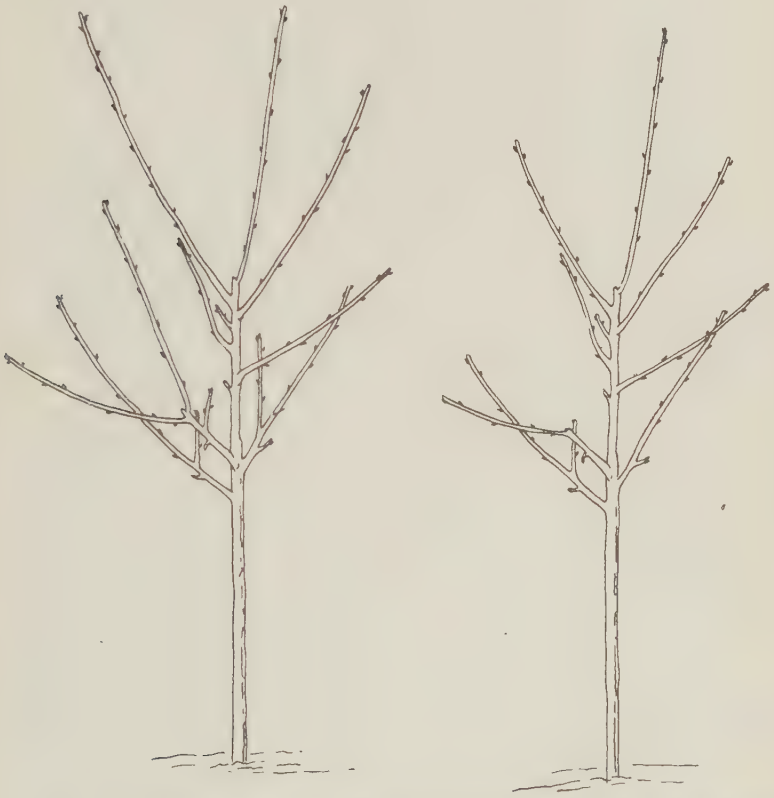


Fig. 7. Stayman tree after one season's growth, two years old when set, before and after spring pruning. A slight heading in of long shoots, and a little thinning of interfering branches was all the pruning needed

[1] Transactions Indiana Horticultural Society for 1880, page 25

CHANGE IN ORCHARD CONDITIONS

The general condition of the Indiana apple orchards during the past 25 or 30 years had probably been growing worse rather than better until a recent date. Until within a very few years, the home orchards have been generally neglected. Even the majority of the owners of so called commercial orchards have failed to protect the apple crop from its multiplying enemies. One significant change has been taking place. Whereas, a generation ago, only the beginnings had been made in the scientific study and systematic control of orchard pests, at the present time efficient remedies for most of them are at hand. It has taken a generation of research to accomplish this. Since the establishment of the experiment stations in 1887, progress has been wonderfully rapid. Much, of course, remains to be done. Nevertheless, the relation of the apple grower to the enemies of his orchard has been radically and forever changed during the past 35 years. Weapons have been made for him and put into his hands. He may use them if he will. Some orchardists have followed every development of control measures, working with, sometimes following and sometimes leading and correcting the scientist in his search for new truth. These men are today conspicuous for their success and their names are on many lips. Many, on the other hand, have become discouraged and are convinced that apples no longer pay, and their orchards are testimonials to the soundness of their judgment so far as it applies to themselves.

This development of control measures to the point where the efficiency of their results is simply the gauge of the thoroughness of their use, together with the accompanying increase of pests of every description to the point where the neglected orchard is doomed to destruction, is a phenomenon of evolution full of significance to the commercial apple grower. It means that the day of chance failure and chance success has passed. This is only another way of saying that the day has come when skill, energy and intelligence, if applied to the growing of apples, may receive their due reward.

Commercial apple growing today is on a more definite business basis than ever before. More is required of the apple grower than ever before. He must know his business more thoroughly and there is more of his business to know than there was in the good old days. The day of the specialist has arrived. The day of the commercial orchard as an incidental sideline to a general farming business has gone.

Since it has become apparent that the producing of perfect fruit is no longer a matter of chance but is, to an ever increasing extent, a question of skill and applied science, the apple growing industry is proving an attractive field for the investor. Experts



Fig. 8. Before and after second season's pruning. This young Jonathan made a vigorous growth the first summer and required considerable thinning to avoid future over-crowding. The long, light growths were headed in to induce stockiness

are already over the land, hunting out the old neglected orchards and, protected from loss by a long time lease, are putting into vigorous practice those modern remedial and control measures whose omission in the past has led to the failure of the orchard. Large companies are being formed for speculation in fruit lands, for exploitation of orchard renovation schemes or for straight-forward business development of commercial apple growing. Immense or-

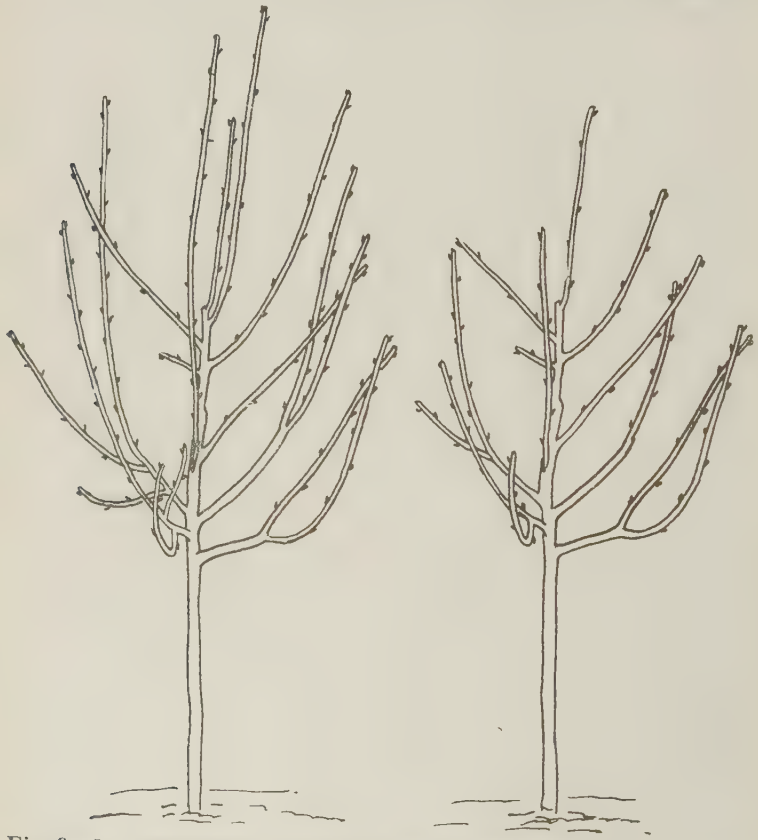


Fig. 9. In this case the competing leader was removed and interfering branches cut out. A slight heading in of the longer branches completed the second season's pruning

chards are being put out, not only in Indiana but also in surrounding states.

It is not in Indiana alone that this horticultural revolution has been taking place, but perhaps horticulture in Indiana has come to

life more rapidly than in most surrounding localities. Everywhere the discouragement over the old conditions is giving place to optimism over the present conditions and future prospects. This revival of interest in fruit growing is registered in the Purdue Department of Horticulture in many ways. The number of inquiries per week on orchard subjects is greater now than the number per month four years ago. Various manufacturers of spray pumps and spray materials report an increase in their Indiana sales for the spring of 1911 of from 50 per cent. to 500 per cent. over sales for the same period in 1910. Several state that the increase of 1910 over 1909 was about as great. We cannot escape, if we would, the fact that a distinct revival movement is on us in respect to the apple industry.

Owing to the slowness with which modern methods have been adopted, the actual apple production of the middle states has decreased in the last 10 years. Until recently the orchard pests have been able to keep ahead of the spray pumps. The demand for well grown apples has been steadily increasing and the price has been going higher. This decreasing supply, increasing demand and the elimination of chance in the production of good fruit have all played their part in the wonderful awakening of interest in the subject which has taken place within such a comparatively short time. Other factors have doubtless had some effect in this awakening. Every phase of rural life has been the subject of more study and interest during the past decade than ever before. Everything agricultural has taken on new significance in the eyes of the whole people. In the social movement suggested by the phrase "back to the land," fruit growing occupies a peculiarly attrac-



Fig. 10. This tree was not properly pruned when young, hence developed a set of competing leaders. Repeated pruning to an outside bud, helps to correct the close, upright habit of growth of some varieties. By proper pruning for the first few years, this kind of poor top can be avoided



Fig. 11. Pruning knife. Many prefer this to shears for working about young trees. Be sure it is sharp

tive position. The rapid rise to horticultural prominence of the Pacific northwest has also been a contributing factor in the middle west awakening. The market for first-class apples is better than ever before and is capable of indefinite future development. The increase in the demand is apparently out of proportion to the increase in population and has certainly been greater than the increase in supply. People are apparently getting the apple eating habit. The splendid product put out from some of the western states and the record prices received for that product have advertised through the whole country the commercial possibilities of the business when carried on in a business-like and up-to-date fashion. People everywhere have asked, "If ——— can spray so as to control insects and diseases perfectly and can pack and grade so as to realize 50 cents net per box, why can not Indiana apple growers do likewise?" Many have put their own question to the test and have answered it to their own thorough satisfaction. They are now the most enthusiastic apostles of apple growing in the middle west. Others are imitating them and are demonstrating over again to themselves, the proposition that the percentage of sound fruit at harvest time is an exact register of the intelligence with which known methods of insect and disease control are applied to the care of the crop.

Another factor in the aroused interest in apple growing has undoubtedly been the Department of Horticulture at Purdue. The horticultural phase of the country life movement developed a general but vague and groping interest in Indiana fruit growing. The commercial success of the northwest directed a more intelligent inquiry into the possibilities of our own state along the same line. The efforts of the Department during the past three years have helped to shape the growing interest and are now leading it into channels

of direct usefulness and profit to the state.

ECONOMIC FOUNDATIONS OF SUCCESSFUL APPLE GROWING

What is the stake of Indiana in the horticultural revolution now taking place? What position may the state expect to occupy in the apple growing industry of the future? Under the impetus of the newly aroused interest in the business, many new orchards are being set; what will be their future development? What are the natural conditions, either advantageous or the reverse, surrounding apple growing in Indiana which make it more or less profitable than apple growing in other localities? How about overproduction? These are some of the questions which are being asked the Department of Horticulture daily by dozens of alert individuals who are interested in the development of modern fruit growing.

It is easy to point out the present condition. It is a condition of ferment. Horticulture is awake in Indiana as it never was awake before. It is less easy to analyze this condition in all its bearings and to predict from the forward movement of today just how great will be the development of tomorrow. The spirit underlying the present movement is commercial. The care of fruit trees is not prompted by the unselfish devotion of enthusiastic amateurs as in the early days, but to an ever increasing extent is prompted by the interest of the man who wishes to make money in apple growing. There is probably just as much love as ever before for the old home orchard, but

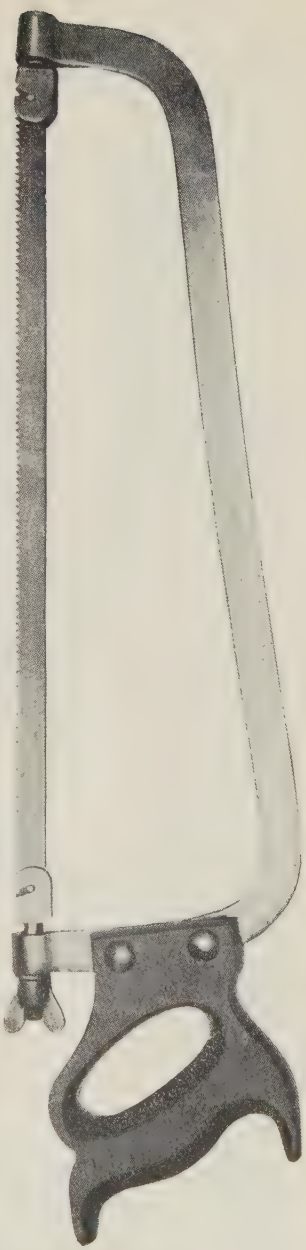


Fig. 12. Open back, swivel-bladed pruning saw. An excellent type



Fig. 13. This type is especially convenient for working in old, thick-topped trees

there is a stronger insistence than ever before that the old home orchard shall pay its way. Scores of old orchards are being rejuvenated, but with the object, not only of affording an ample supply of good fruit for family use, but also of showing a cash balance on the profit side of the farm account book.

It will be shown by the following discussion how this commercial spirit which is beginning to pervade the business of apple growing in Indiana, is justified by the economic advantages of the state.

The history of the apple in Indiana for over half a century proves that the fruit thrives. There are very few if any, counties in the state which do not show, by their bearing orchards, that they contain some lands at least which are well adapted to the growing of apples. (For discussion of site, see page 34, of soil, page 32.

That the Indiana apple, when properly grown and cared for, is of the highest quality, is admitted by all who are qualified to judge. Many experts declare that the quality of certain varieties as grown in southern Indiana is far superior to that attained by the same sorts in certain parts of the west and northwest. The premiums for quality which have been won by Indiana apples at national shows, seem to indicate that this judgment is not without foundation.

It has been shown that the more recent advances made toward perfecting means of holding insects and diseases in check have put it in the power of the apple grower to protect his crop if he will. It need scarcely be pointed out that control measures are no more difficult or costly to put into practice in Indiana than they are in any other locality and that numerous Indiana apple

growers are continually proving the efficiency of modern treatment.

In considering the relative merits of different sections of the country for the production of any specific crop, certain broad economic problems of land values and initial investment, of markets and transportation are fundamental to the whole subject.

Price of Land.—Indiana is particularly attractive to the prospective commercial apple grower on account of her low priced fruit lands. It is customary to value a piece of income producing property on the basis of the investment on which it may be expected to return a fair rate of interest. Apple lands in various parts of the Pacific northwest are said to be held at prices varying from $200 to $600 per acre for uncleared land and at from $1000 to $4000 per acre for bearing orchards. No doubt this valuation is often justified on ordinary business grounds. If a bearing orchard will return $100 per acre net profit, it is reasonable to value that orchard at $1000 per acre because it is returning 10 per cent. interest on such a valuation. If it will return $500 per acre profit, the orchard may well be valued at $5000 per acre. If unplanted land in the same vicinity, suitable for apple growing, can be prepared, set to trees and those trees brought to bearing age at a total investment of $200 per acre, and if the bearing orchard for the next five years will return a profit of from $50 to $100 per acre per year (10 per cent. interest on a valuation of $500 to $1000 per acre) it can not be considered unreasonable if such lands be held to be worth from $300 to $500 per acre.

Exact data as to the cost of setting a commercial orchard and bringing it to bearing age, are scanty. A liberal estimate

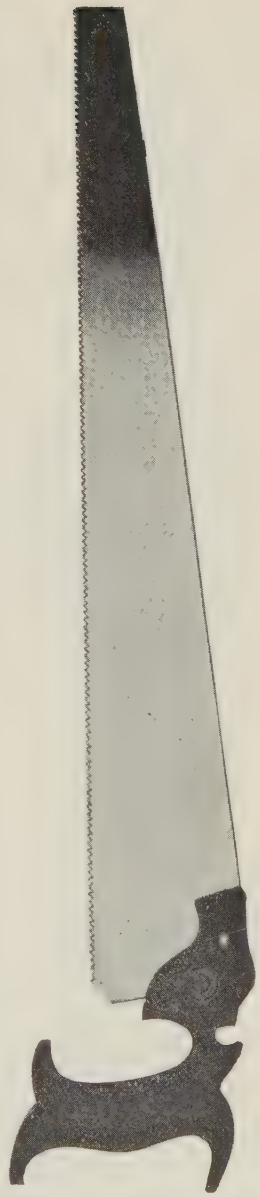


Fig. 14. Straight blade, single edge, high grade pruning saw. A good type



Fig. 15. "Perfection" pruning shear. A good type

is $15 to $20 per acre per year, for the first seven years, this cost not including the original purchase price of the land. On account of labor conditions, the cost is less rather than more in the middle west than in the far west. Thousands of acres of excellent apple land can be bought at this time in Indiana for less than $100 per acre. In certain sections of the state during the past 12 months, exceedingly well located apple land has been purchased for from $25 to $40 per acre. In some cases, lands suitable for apple growing are held as low as $15 to $20 per acre.

The price of these apple lands is so low at present, because their adaptability for fruit production is only now becoming recognized. They are and have been valued, not on the basis of the investment on which they will return a fair rate of interest when supporting well-cared-for commercial orchards, but on the basis of the investment on which they will return a fair rate of interest when handled as general farms growing general farm crops and live stock, under the defective sort of business administration for which American farmers are so often criticised. There are, of course, innumerable splendid orchard localities which are also excellent general farming localities and where the price of land is proportionately higher, $100 to $150 or even $200 per acre. There are enough producing orchards in the state, on land identical with that which can be bought for $40 to $80, to show what the valuation of this land would be if such valuation were made on an orchard income basis. From a small block (two and one-half acres) of 22-year old Grimes, the gross income in 1910 was $3200, three-fourths of this amount being estimated as net profit for the season. On the basis of 10 per cent. interest on investment, this orchard should be worth $9600 per acre. This is no doubt an extreme case,

but it illustrates very forcibly what can be and is being done. Instances of profit of from $100 to $500 per acre in a single season might be multiplied indefinitely.

Compared with many other fruit growing localities, then, Indiana enjoys an undoubted advantage in the low price of her fruit lands. The initial investment for engaging in commercial fruit growing in this state is very substantially less than in many other parts of the country, notably in most of the widely advertised sections of the west and northwest.

Transportation and Markets.—Indiana is well located with respect to markets. At the present time it is estimated that the home grown product fails to satisfy the home demand by from one to three million dollars worth of apples per year. The home demand, although already considerably in excess of the supply, is capable of almost indefinite future development. Distribution (not transportation facilities) is so poor and supply is so inadequate at present that in numberless small towns of the state it is almost impossible to procure first-class apples, through a large part of the year. The large number of great trunk lines covering the state from east to west as well as the network of branch lines and interurban electric roads in every direction, make it unusually easy to place fruit promptly in both the large and the small cities of the middle west and east.

It is estimated that there are 10,000,000 people within 24 hours by rail of Indianapolis.

As to actual costs of transportation, the following figures are suggestive, and, so far as they go, are authoritative at the present time.

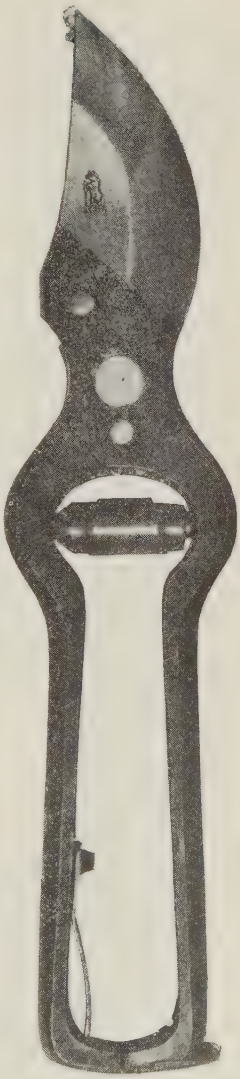


Fig. 16. "German" hand shear. A high grade tool for heavy work

Freight rates (July, 1911) on apples in car lots from various points in the United States to Chicago, New York and other markets:

From[1]	To	Rate per 100 pounds	Minimum car	Rate per full car
Indianapolis	Chicago	$.115	24000 lbs.	$27.60
Indianapolis	New York	.28	" "	67.20
Indianapolis	Cincinnati	.095	" "	22.80
Lafayette	Chicago	.10	" "	24.00
Seymour	Cincinnati	.09	" "	21.60
Seymour	St. Louis	.14	" "	33.60
Vincennes	St. Louis	.105	" "	25.20
Vincennes	Cincinnati	.115	" "	27.60
Vincennes	Chicago	.135	" "	32.40
Vincennes	New York	.31	" "	74.40
Paoli	Chicago	.17	" "	40.80
Bedford	Chicago	.135	" "	32.40
Ft. Wayne	Chicago	.105	" "	25.20
Ft. Wayne	New York	.270	" "	64.80
Hood River, Oregon	Chicago	1.00	30000 lbs.	300.00
Hood River, Oregon	New York	1.00	" "	300.00
San Francisco, Cal., Ogden, Salt Lake City, Utah, etc.	Chicago	.85	" "	255.00

[1] Vincennes, Seymour, Ft. Wayne and Indianapolis are mentioned particularly in this table because of the excellent cold storage equipment for apples at each of these points

It will be noted that Indianapolis has an advantage over Pacific coast points of $272.40 in freight rates alone, in putting a carload of apples on the Chicago market, and of $232.80 in reaching New York. Other Indiana shipping points present the same contrast in varying degree and indicate the advantage the Indiana apple grower enjoys in reaching his market at relatively small cost.

SUMMARY

If the facts adduced in the foregoing discussion be admitted it is evident that Indiana offers unusual opportunities for commercial apple growing. The quality of well-grown Indiana fruit is of the best. The cost of production is lower in Indiana than in many localities on account of the relatively low price of land. The transportation facilities are excellent in nearly every section of the state. The great markets of the country can be easily and quickly reached. The home markets are very inadequately supplied during the greater part of the year. The transportation costs are decidedly lower than in many celebrated apple growing localities. A comparison of freight rates now in force indicates that Indiana orchardists, if they will grow, grade and pack their fruit as well as their western competitors do, so as to sell at the same price, can make approximately $275 a car more profit or can undersell by that amount and make the same profit that the western growers make.

In view of these conditions, it is the belief of the writers, that the commercial spirit of Indiana apple growing is abundantly justified and that no more is needed than the application of principles and methods of fruit growing already known, to put Indiana in the front rank among the apple producing states of the middle west.

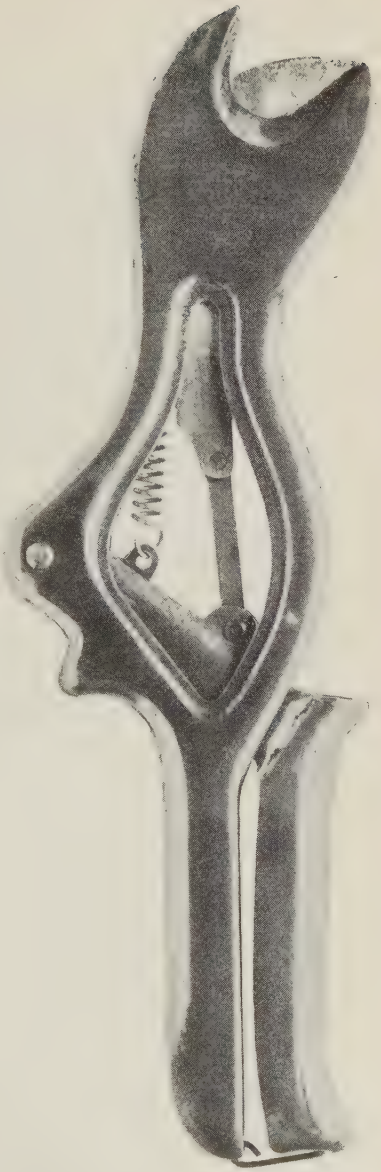


Fig. 17. An undesirable type of hand pruner



Fig. 18. A double cut hand shear. Not desirable

A WORD OF CAUTION

The rapid development which is now taking place contains elements of danger as well as elements of promise. The business of commercial apple growing may be safely and profitably developed until Indiana is a heavy seller instead of a heavy buyer of apples. The danger lies in the exploitation, rather than in the development of the industry; in the sale of stock in speculative schemes rather than in the sale of apples to consumers or of apple lands to apple growers.

On account of the large profits which may be and are being made by persons who are thoroughly trained and expert in the business there is a temptation to the horticulturally ignorant, and to the inexpert to rush into apple growing without adequate information or expert advice to guide them. All lands are not adapted to apple growing. In localities where the soil is generally excellent all sites are not proper for orchards. Many orchards will be set and many will fail. If an apple orchard in Indiana or anywhere else is a financial success it means that some one with expert knowledge has realized and has fulfilled the conditions of success; it means that skill, energy, technical ability and good business judgment have been exercised. If these qualities are not part of the personal equipment of the prospective apple grower, they must be secured from some source if the orchard is to thrive.

II.—THE YOUNG ORCHARD

The following is a brief discussion of some of the factors which must be considered in bringing to concrete realization the idea of a successful commercial orchard.

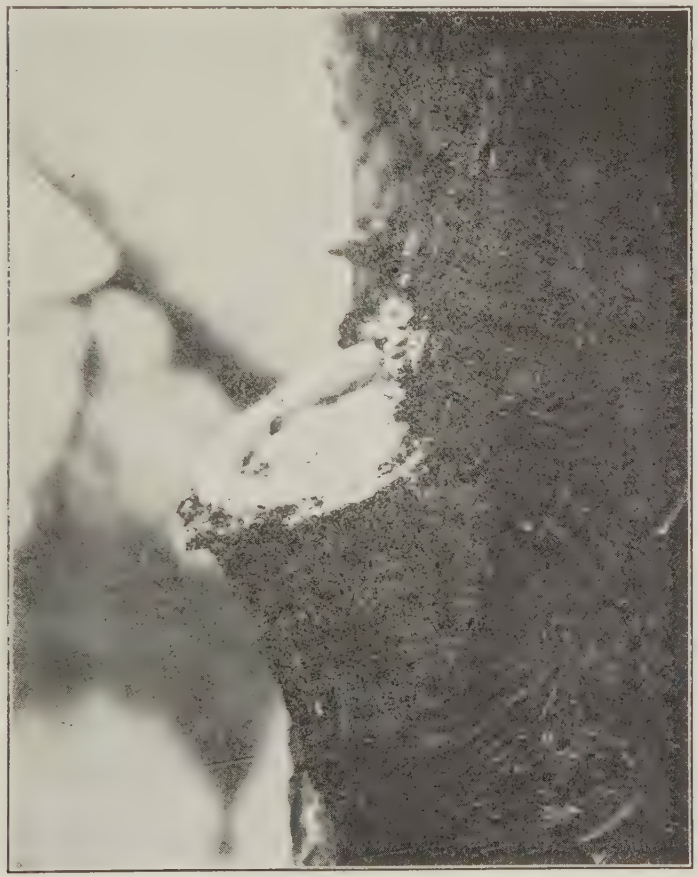


Fig. 19. Bad pruning. The cut should have been made parallel to main branch instead of at right angles to the branch removed

Different Parts of the State.—The location of the orchard is one of the first points to be decided. In connection with the problem there are a number of considerations which have an important effect in the success or failure of the undertaking. In general

that part of the state lying south of an east and west line passing through Indianapolis, offers the lowest priced apple land. In many parts of this southern section, well located land suitable for apple growing may be bought for the prices before mentioned or for from



Fig. 20. Do not leave shoulder like this in pruning. It cannot heal over. The white line shows where the cut should have been made

$40 to $80 per acre. Land affording splendid orchard sites, but lying further from the railroad may sometimes be bought for considerably less than this price. While there is a great diversity in soil conditions and in the character of the country in this part of the

state, it is in the main, more rolling, hilly and diversified than the central and northern sections. Apple lands in the southern part of the state are generally somewhat lower in price because, as a rule, they are not so well adapted to grain farming and especially to corn growing as some other sections.



Fig. 21. Another kind of poor pruning. The stub was left too long and the healing callous cannot quite grow over it. It will eventually rot

The central part of the state contains considerable land not particularly well adapted to the growing of the tree fruits. In general this land consists of broad level reaches of prairie, usually dark in color, often with poor natural drainage and inevitably subject to a greater or less degree, to danger of injury from late spring frosts. These lands are famous for the production of corn. As noted earlier, however, while this sort of land is characteristic to

a great degree, of the central third of the state, it is by no means the only type presented, since nearly every county possesses some territory more or less broken, elevated or rolling, which is suitable for fruit production.

In the northern and northeastern parts of the state again the country is more diversified and contains countless small lakes. Numberless localities in the eastern, northern and northeastern counties possess every requisite for successful apple growing. The same is true of the northwestern part of the state if we except the flat and more or less marshy land known as the Kankakee region and drained

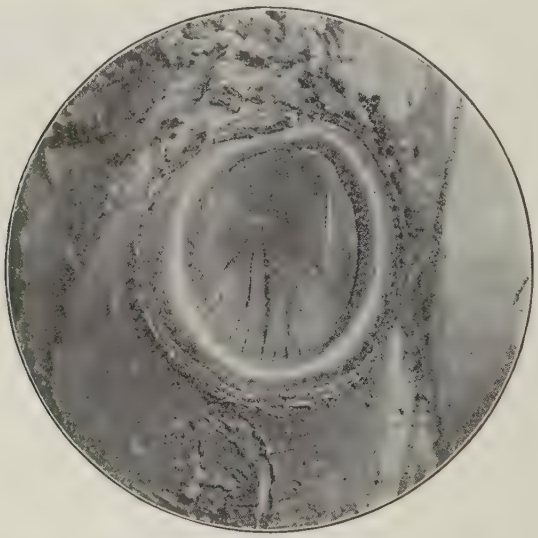


Fig. 22. A well made cut. The callous will soon cover the wound, which should be protected with paint until healed

by the Kankakee river and tributary streams. The eastern and northern parts of the state possess some of the best fruit growing localities which could be desired and supported excellent orchards more than 50 years ago. Much of this land is well adapted to general farming. It was settled early and has long been improved and if for sale at all, is often held at from $150 to $225 per acre.

The final decision as to the section of the state in which to start a commercial orchard is, of course, a matter of individual judgment. The following suggestions may be considered in arriving at such decision.

General Factors of Location.—The orchard should be near a good shipping point. This is a very elementary consideration and yet is often overlooked until the orchard is of bearing age when the extra expense and difficulty of marketing materially reduce the profits from the crop. It is preferable to have such a location as will provide a convenient outlet to more than one market. It is also a decided advantage if two or more competing lines are available for patronage, such as steam and electric roads or transportation by both water and rail.

The transportation facilities should be investigated with reference to convenience of service, time en route from the loading station to probable markets, frequency of service, rates and prospective improvement.

The matter of good roads is not to be overlooked. Up to a cer-

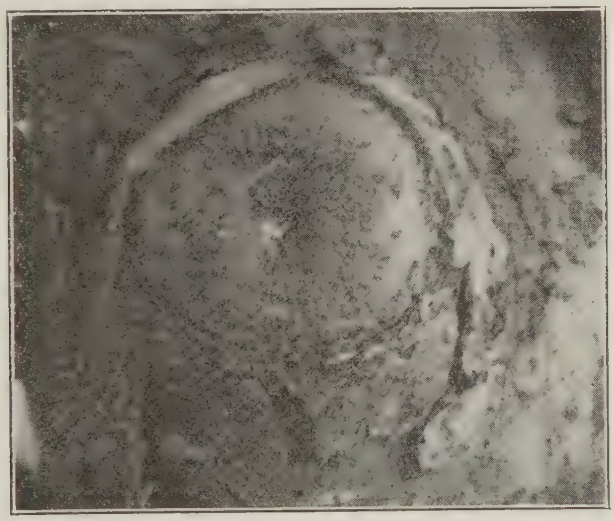


Fig. 23. A properly made pruning wound nearly healed over. The tree will cover the wounds if it has a chance

tain point the cost of marketing depends directly on the size of the load which can be hauled and the resulting total quantity it will be possible to deliver at the loading station in a day's work. The length of haul is possibly of even greater importance than the quality of the roads. The roads may be improved in a short time; a long haul cannot be remedied and like the road question, directly affects the cost of marketing and the consequent profit from the orchard.



Fig. 24. A mature orchard under sod-mulch management. The grass is cut and allowed to lie where it falls. This mulch is supplemented with straw, as the grass alone does not furnish sufficient mulch to properly conserve soil moisture



Fig. 25. Apple orchard under clean cultivation. The trees are cultivated as carefully as any other crop would be. A dust mulch is an efficient protection against loss of soil moisture. A cover crop is put in about mid-summer to remain till the following spring

Availability of labor supply is worth looking into, especially if the orchard is large and is to be started in a community where fruit growing is not already established on a commercial scale.

The presence of other commercial orchards is nearly always an advantage. Buyers are attracted to producing centers making it easy for every one to sell at a fair price whereas, with only one orchard in a community, there is not enough fruit produced to attract buyers and the grower is liable to labor under more or less of a handicap in disposing of his crop. With a number of large orchards in a locality, cooperation is possible. A selling association may be formed, which will be a benefit to every one; cooperative whole-



Fig. 26. Cover crop of crimson clover as it appeared last spring in one of the Purdue orchards. A fine growth is shown which is ready to turn under to add fertility and humus to the soil

sale buying may be practiced and spray materials, barrels, boxes and other supplies purchased in large quantities at a saving to all. It is far easier to obtain skilled help in a distinctly fruit growing community, etc.

DETAILS OF LOCATION

Soils.—The apple thrives in Indiana on a great variety of soils. The suitable soils are so diverse that they may perhaps best be indicated by negatives. Thus in general very light soils are not suitable because they dry out too easily and because on these soils trees

are not generally long lived. Peaches will thrive as a rule on lighter soils than apples. Shallow soils where unbroken rock comes very near the surface are not suitable. The same is true and possibly in an even greater degree, of soils underlaid with an impervious hard pan. Broken rock near the surface is not especially objectionable. Soils either naturally poor in available plant food or depleted to the point of exhaustion by years of poor farming and hard cropping, should be avoided. Poorly drained soils should never be used. A good indication of the suitability of a soil for apple growing, which



Fig. 27. One kind of double cropping found profitable in a young commercial orchard at the Purdue Station. Strawberries are grown between the young trees

is sometimes available, is the presence of old apple trees. Many localities advertise themselves continually as excellent for apple orchards by the scattered old trees they still support. These gnarled and hoary relics tell their own story of neglect striving with the innate possibilities of the soil.

In general, apple soils should be fairly strong, not depleted of their natural supply of available plant food, well drained and fairly deep. They may vary from a light loam to a heavy clay. Nearly any good general farming soil is good apple soil. Certain varieties thrive especially well on the red clay lands, usually under-

laid with broken limestone, which are so common in parts of southern Indiana. Some sections of southern Indiana, however, are not good for apple growing. The flat, poorly drained white clay lands of parts of Scott and adjacent counties are as unfavorable for orcharding as the level black muck lands of Stark county and other sections in the north.

SITE.—By site is meant the particular location of the orchard, with respect to exposure, elevation, etc. The prime consideration in selecting the orchard site, after the soil conditions have been satisfactorily met, is air drainage. This is usually not difficult to secure in



Fig. 28. In this young orchard potatoes are grown between the trees. Ample room is allowed for clean cultivation about the trees, and the potatoes are off in time to allow the putting in of a cover crop

rolling country. Its lack is the great handicap of flat lands. Good air drainage obviates to a great degree, damage from late spring frosts. Still, cold air seeks the lower levels. It flows away from the elevated sites and collects in the hollows. For this reason elevated sites are most desirable for apple orchards. For this reason "pockets" or depressions from which the cold air cannot escape should always be avoided. The orchard site may be practically level and yet be most desirable if it be elevated and if the conformation of the surrounding country is such as to ensure the necessary air drainage. On the other hand, the site may be broken and hilly and also be excellent. Broken ground may be enough cheaper and

may be so situated with respect to shipping facilities, etc., as to make its advantages more than offset the greater ease in harvesting and of care afforded by the more level sites. The famous Rome Beauty section of Lawrence county, Ohio, consists almost wholly of land so rough that in many parts of the country it would be considered wholly unsuitable for orchard purposes. Very similar conditions obtain in many of our own Ohio river counties.

Exposure.—Much has been written on the effect of exposure on the behavior and ripening of the fruit. It has been contended that the southern slope hastens the ripening of the fruit and gives



Fig. 29. The double extension cutaway disk. This is one of the best tools for orchard work

it higher color. It is also argued that trees on the warmer exposures are stimulated to activity too early in the spring, making the bloom by reason of its earliness more susceptible to spring frost injury. It is probable that the relative advantages of various exposures depend partly on the geographical location of the orchard site. Local conditions also have their effect. In southern Indiana which is well south among commercial apple sections, it is probable that the cooler exposures are generally preferable. If the orchard site is close to a large lake, the preferable slope is usually toward the water. In regions exposed to high winds, the exposure may be a factor in protecting the orchard from damage. Unless the slope is very pro-

nounced, it is doubtful if the blooming period is either hastened or retarded enough to be worth considering. The matter of varieties has some effect also. In the northern extremity of the state, it is possible that higher color will be obtained on the southern exposure,



Fig. 30. A good specimen of a young apple tree, toward the end of the second season's growth. Note the wire cloth tree protector to prevent rabbit injury

but even here it is questionable if the amount of foliage and the soil conditions are not of greater effect than the sun. With only slight slope and uniform soil to consider, the exposure is an unimportant matter.

Selection of Varieties.—The selection of varieties for the commercial orchard is usually determined by a number of pretty definite considerations, among which are:—

1. Adaptation of the variety to the locality in which it is to be grown. Some varieties are very cosmopolitan in their tastes. Most of the noted commercial sorts have become so because of this very quality, which has enabled them to thrive under widely varying conditions. Nevertheless, most varieties possess a certain range, within which they reach their greatest excellence and outside of which they are surpassed by others.



Fig. 31. A harvest scene in a profitable southern Indiana orchard

2. Adaptation of the variety to the market it is expected to supply. It used to be said that the commercial apple grower need not consider quality. This advice is obsolete. It should rather be said that the commercial grower should know pretty definitely what market he hopes to supply and should select his varieties accordingly. If he wishes to grow apples for the fancy trade, and to realize the highest price for his crop, he will pay particular attention to quality. He will then grow his crop with only secondary attention to the cost of production. He will prune, spray, fertilize, grade and pack with such honesty and uniformity as to put the best possible



Fig. 32. These barrels of southern Indiana Winesaps are well faced but not quite full enough. The barrel is the leading commercial package for the bulk of the middle-west crop

product on the market. He will market everything under his own name and strive to build up such a reputation as will make his fruit sell itself and that at a premium over the general market price.

Another type of commercial grower will be most intent on large yields, and will use every effort to keep the cost of growing and marketing to an absolute minimum. He will care only secondarily for quality. He will market his fruit in a wholesale way, caring little for the special markets, and will depend for his profit on supplying the great demand in the consuming centers for a fairly good apple at a low price.



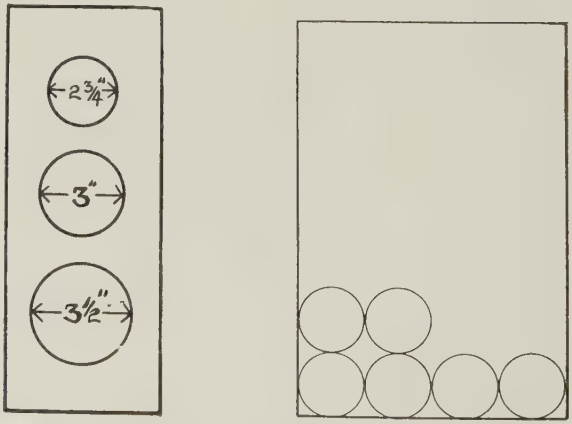
Fig. 33. Box versus barrel. When this photo was made in the storage house the carefully graded, skillfully packed box of apples, holding one bushel, was selling for as much as the barrel, holding three bushels. Which is most profitable?

There is a place for both kinds of apple growers, but their selection of varieties will be somewhat different.

3. In addition to these two principles of selection, any variety which it is proposed to grow in commercial quantities will be judged for its season, keeping quality, earliness and regularity of bearing, shipping quality, hardiness and vigor of tree and susceptibility of both tree and fruit to insect and disease attack.

The commercial fruit grower will confine his attention to a few varieties. If he wishes to experiment or to grow a large number of varieties, he will set aside a plot of ground for this especial purpose and there put one or two trees of a kind of as many varieties as he wishes to possess. He will not divide his main commercial planting into a few hundred trees each of a dozen or 15 sorts. No absolute limit can be set, of course, but many growers hold that the commercial orchard should never contain more than five varieties. Many of the most successful consider that three is sufficient. The reasons for this are obvious and lie in the simplicity of handling and effectiveness in selling a few varieties instead of many.

It is not desirable that the planting be confined to a single sort



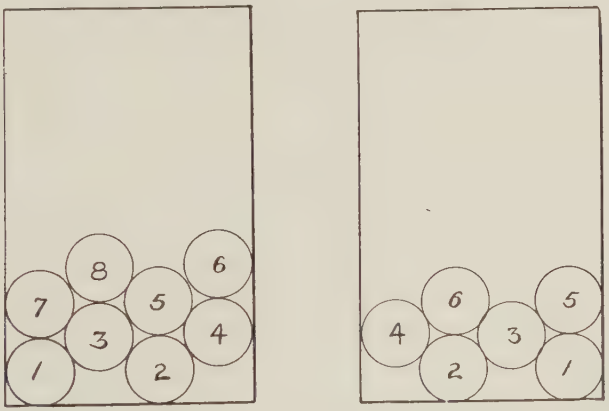
Figs. 34 and 35. Grading board at left for sizing apples. At right is shown start of straight pack, four layers deep, 96 apples per box

on account of the general advantage of cross pollination. A few varieties, such as Baldwin, seem to be self-fertile and to do just as well when set in large blocks by themselves as when other sorts are interspersed. This is the exception, however, rather than the rule. Some varieties set very little fruit if dependent on their own pollination and nearly all do better if set with other sorts.

The commercial apple grower will beware of novelties. No sort should be largely set in commercial plantings until its place is assured. There are a sufficient number of varieties that have been thoroughly tried in the state, that are adapted to Indiana conditions and that are well known in the markets, so that no one need take chances with novelties or strangers of doubtful reputation and unestablished credit. The varieties that have already been thoroughly

tried, that have proved their merit in thousands of orchards and which are known and demanded in the market, will continue to have their place. Other good sorts will doubtless prove valuable in time. Some may eventually take their place beside the favorites of today but will not soon supercede them.

The following list of varieties while not exhaustive is probably sufficient for the needs of the commercial grower at the present time. It represents the judgment of no one individual, however expert, but is a composite of the results of years of variety testing by the Station and by individuals, of the investigations of the Bureau of Pomology of the U. S. Department of Agriculture and has been recently revised after being submitted to a number of the most experienced and competent apple growers of the state.



Figs. 36 and 37. First and second layer of the 5-5, 3½ tier-diagonal pack, 80 apples per box. First layer started at left, second layer at right, showing order of placing apples in position

VARIETIES FOR COMMERCIAL PLANTING

Northern Indiana	Southern Indiana
Baldwin	Akin
Grimes	Ben Davis
Hubbardston (Hubbardston Nonesuch)	Benoni
Jonathan	Gano
Maiden Blush	Grimes
Northern Spy	Jonathan
Oldenburg (Duchess of Oldenburg)	Oldenburg
Rome Beauty	Rome Beauty
Stayman	Stayman
Wagener	Wealthy
Wealthy	Winesap
Yellow Transparent	Yellow Transparent
	York Imperial

Description of Varieties Recommended

Southern Indiana

Akin.—*Tree*: upright, dense, moderately vigorous, biennial bearer. *Fruit*: season, December to May; color, bright red; size, medium; quality, very good; flavor, sprightly subacid; use, dessert. Specially adapted for fancy trade and dessert use.

Ben Davis.—*Tree*: spreading, dense, rank growing, biennial bearer. *Fruit*: season, January to June; color, yellow overlaid with bright, deep red splashes; size, large; quality, fair to good if used in season; flavor, mildly subacid; use, market. The fruit is thick-skinned, does not show bruises easily, and presents a good appearance in the package after being handled and shipped in the ordinary way.

Benoni.—*Tree*: vigorous, upright, spreading, dense, productive, biennial bearer. *Fruit*: season, August; color, rich yellow with crimson cheek; size, small to medium; quality, very good; flavor, pleasant subacid; use, dessert. Very attractive apple, excellent in quality. Adapted for fancy trade. Resistant to blotch.

Gano.—*Tree*: vigorous, upright, spreading, becoming somewhat drooping, rather dense, regular bearer. *Fruit*: season, December to May; color, fine red; size, medium; quality, about the same as Ben Davis, to which it seems to be closely related; flavor, mild subacid; use, market. A very attractive apple, stands handling well and is a good keeper.

GRIMES.—*Tree*: moderately vigorous, spreading, dense, fruit borne to center, annual bearer. *Fruit*: season, November to January; color, rich golden-yellow; size, medium to large; quality, best; flavor, rich, subacid, aromatic; use, dessert, market. This variety is the standard of high quality. For this state nothing better is known.

JONATHAN.—*Tree*: vigorous, roundish, slightly drooping, dense, annual bearer. *Fruit*: season, November to January; color, brilliant dark red on sunny side, on shady side mixed and striped with lighter red; size, medium; quality, very good to best; flavor, sprightly subacid, spicy; use, dessert, market. One of the most desirable varieties for the fancy trade of the holiday season.

OLDENBURG.—*Tree*: at first upright, open, later, roundish. *Fruit*: season, July to August; color, greenish yellow covered with irregular splashes and stripes of light red, mottled and shaded with crimson; size, medium to large; quality, fair to good; flavor, sour; use, culinary, too much acid for dessert. Fruits are quite uniform in size and quality, with but a small percentage of loss from unmarketable fruit.

ROME.—*Tree*: rather vigorous, slightly spreading, dense, slender lateral branches, annual cropper. *Fruit*: season, November to March; color, red mingled with yellow; size, medium to large; quality, good; flavor, agreeable, mild subacid, aromatic; use, market. This variety holds well in storage, is not subject to scald, has an established reputation in market and sells at good prices.

STAYMAN.—*Tree*: moderately vigorous, spreading, open, annual bearer. *Fruit*: season, November to May; color, greenish yellow partly overlaid with dull red; size, medium to large; quality, very good; flavor, very juicy, pleasant subacid; use, dessert and market. Adapted to wider range of soil than parent Winesap, but has less brilliant color.

WEALTHY.—*Tree*: medium in size, moderately vigorous, upright, open, biennial bearer. *Fruit*: season, August to October; color, bright red; size, medium to large on young trees, but smaller on old trees; quality, very good; flavor, very juicy, agreeably subacid; use, culinary, dessert and market. The crop ripens unevenly and more than one picking should be made in order to secure best results. Has tendency to overbear.

WINESAP.—*Tree*: vigorous, spreading, straggling, open, regular bearer. *Fruit*: season, November to May; color, bright deep red; size, medium; quality, very good; flavor, rich, sprightly subacid; use, dessert. One of the oldest and most popular apples in America.

Yellow Transparent.—*Tree*: moderately vigorous, upright, dense, hardy, subject to blight attacks, annual bearer. *Fruit*: season, July; color, attractive, clear yellowish white; size, medium; quality, good; flavor, sprightly subacid; use, culinary, acceptable for dessert. One of the best extra early varieties. Must be handled with care as the delicate color and tender skin show bruises very readily.

York Imperial. — *Tree*: vigorous, upright, spreading, dense, productive, annual bearer. *Fruit*: season, November to April; color, yellow overlaid with red and carmine; size, medium to large; quality, good to very good; flavor, aromatic, mildly subacid; use, market, dessert. Some object to this variety on account of its lopsided or oblique shape which makes it difficult to pack and to pare with machines.

Northern Indiana

Baldwin.—*Tree*: large, very vigorous, upright, spreading, biennial cropper. *Fruit*: season, November to April; color, bright red flecked with large russet dots; size, medium to large; quality, good to very good; flavor, agreeably subacid, sprightly, aromatic; use, general market, dessert. Baldwin is the standard market apple in the Eastern states and is also one of the principal apples used for export trade.

Grimes.—(see southern list)

Hubbardston.—*Tree*; medium to large, hardy, vigorous, upright, spreading, very productive, requires heavy thinning. *Fruit*: season, October to January; color, yellow generally overlaid with orange red; size, large; quality, very good; flavor, rich, aromatic, mildly subacid, mingled with sweet; use, dessert. The tree is somewhat susceptible to attacks of apple canker.

Jonathan.—(see southern list)

Maiden Blush.—*Tree*: medium size, hardy, vigorous, upright, spreading, annual bearer. *Fruit*: season, September to October; color, pale lemon with crimson cheek; size, above medium; quality, good; flavor, aromatic, pleasant subacid; use, culinary, acceptable for dessert. It is recognized as a standard market variety and usually sells above the average price for varieties of its class. It has a tender skin and must be handled carefully. Is very subject to scab.

Northern Spy. — *Tree*: very vigorous, upright, dense, spreading, free growing, very productive. *Fruit*: season, November to May; color, yellow overlaid with bright red with delicate bloom;

size, large; quality, very good to best; flavor, sprightly aromatic, subacid; use, dessert, culinary or market. Tree comes into bearing very late, 12 to 15 years. Should be planted at least 40 feet apart.

OLDENBURG.—(see southern list)

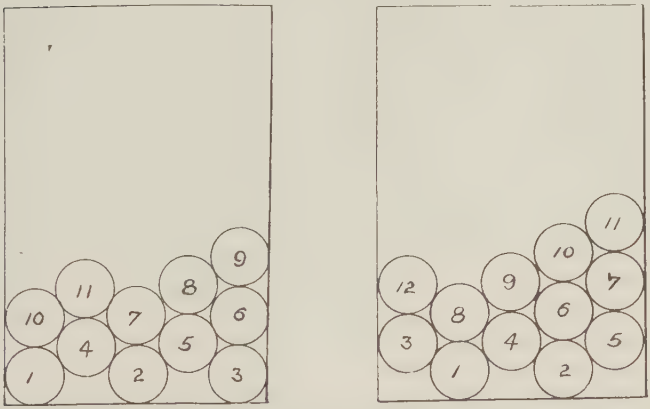
ROME.—(see southern list)

STAYMAN.—(see southern list)

WAGENER.—*Tree*: medium in size, hardy, moderately vigorous, upright, spreading, productive, very early bearer. *Fruit*: season, October to February; color, bright red with some contrasting pale yellow; size, medium to large; quality, very good; flavor, very juicy, aromatic, sprightly subacid; use, dessert, cooking. On account of its dwarfish form and habit of coming into bearing at an early age it is often used as a filler.

WEALTHY.—(see southern list)

YELLOW TRANSPARENT.—(see southern list)



Figs. 38 and 39. First layer at left, second layer at right, of 4½ tier diagonal pack. The apples are five layers deep and pack 163 to the box. Diagonal packing is preferable to straight

Fall versus Spring Planting.—This is a subject of perennial discussion among orchard men. Briefly, some of the advantages adduced in favor of fall planting are: (a) The trees may be set when there is more time for the work and hence the job will be better done. The orchardist's time is also less valuable in the fall and the setting will be less costly. (b) The trees will not have suffered any loss of vitality by nursery storage. (c) Fall buyers have the year's stock to select from and can get a better quality of tree. (d) The roots of fall set trees become established and calloused during the fall and winter and the tree will start growing



Fig. 40. Western boxed apples, straight pack, stored in Indiana and competing with the home-grown product. Indiana growers should begin box packing for their fancy grades

much earlier in the spring than is possible for a spring set tree, thus saving practically a year in time of coming into bearing.

The advocates of spring planting contend that: (a) Fall trees for fall setting are liable to be dug and stripped before the wood is thoroughly mature, thus lowering the vitality of the tree. (b) That early ordering, doing business with nurseries of established reputation and a willingness to pay the price for first-class stock, are better guarantees for getting strong healthy trees than fall

buying. (c) That if properly handled, the nursery tree is better off in the storage house during the winter than it is exposed to the uncertain vicissitudes of winter weather immediately after being set. (d) That in the event of a dry and open winter, the fall set trees will suffer and in the event of a wet fall or winter, unless the drainage is unusually perfect, ice is apt to form about the crown



Fig. 41. At this stage of development, just before the blossom clusters open, the orchard should be sprayed for scab, with dilute lime-sulphur or Bordeaux. Arsenate of lead is added for control of insects

and injure the trees, and hence that it is better policy to allow the trees a little more time and avoid the great danger of winter killing to which from one cause or another fall set trees are exposed.

Both fall and spring setting will continue to have their advocates. The question seems to resolve itself into greater safety in spring setting, vs. a slight saving of time by setting in the fall.

It is certainly true that trees may pass the winter in proper storage and not be injured in any way. It is likewise true that under improper handling and poor storage facilities, injury may and sometimes does occur. The observation and experience of the writers lead them to favor spring setting as usually preferable under Indiana conditions.

The Nursery Tree.—Questions are constantly asked in regard to the relative merits of apple trees propagated by different methods. There are two methods in extensive use, budding and root grafting. In either case the seedling stock is the foundation. Formerly the seedling stocks were generally imported. Some still



Fig. 42. Showing blossom cluster just after petals have fallen. This is the time for the most important spraying for codling moth. Thoroughness of application at this time is absolutely essential

are but most apple stocks are now grown in the west, especially in Kansas. Stock growing is a specialized department of the nursery trade and few nurserymen grow their own. In the case of budded trees the stocks are set in the spring and budded in the nursery row in the summer. The claim is often made that budded trees have a better root system than others. Seedling stocks are used and the scions are usually cut from nursery trees. There has been a great deal of discussion for years in regard to "pedigreed" trees; the meaning usually attaching to this term being the taking of scions

from trees of known individual excellence and bearing quality, rather than from young trees not yet in bearing. It is not yet clear that this method has the wonderful advantage often claimed for it. Another point which is often made much of is the question of whole-root versus piece-root grafts. The usual practice is to make two sections of the seedling root, grafting a scion of the desired variety on to each. Even the matter of the "crown" vs. "tip-root"



Fig. 43. A few days after the petals fall, the calyx lobes close up, as they are beginning to do here. The second spraying of the orchard should be finished before this time

grafts has often been held to be exceedingly important. Again it has been argued that the seedling root is only a temporary support for the young tree in any case, and that by deep planting in the nursery, the newly grafted scion throws out roots above the union, making the tree in time "own-rooted" in any case.

These details of nursery practice are doubtless all more or less important, but should be of interest primarily to the nurseryman

rather than to the tree planters. The latter is interested in buying a *good tree*; if he gets that, true to name, it makes little difference how it has been produced or whether it has been grown in one part of the country or another.

The planter of a commercial orchard has a right to demand that the trees he buys be *well grown, true to name, of good size and shape for the age and variety, free from all dangerous insects and diseases and properly cared for from the time they are dug from the nursery row until they are turned over to him.*



Fig. 44. The time for the third spraying three to four weeks after petals fall

The trees should give evidence of having grown on good soil without any serious check or set-back. They should be clean and healthy in appearance. The limbs should be plump and the bark smooth. The shapeliness and size of the tree will depend somewhat on the variety. It is not fair for the planter, for instance, to demand that a Yellow Transparent or Jonathan which are poor growers in the nursery should be as large and well formed as Ben Davis, Wealthy or Grimes which are good growers in the nursery. For trees which are free from injurious insects and diseases the grower is dependent on the integrity of the nurseryman and the enforcement of the state laws designed for his protection. For trees being true to name, the planter is dependent wholly on the

care and honesty of the nurseryman. It may be said in passing that the majority of disappointments and swindles in this regard which have occurred in the past, have occurred through patronizing the irresponsible traveling agent and the desire on the part of the buyer to get more than value received for his expenditure. The buyer's best safeguard here as elsewhere is to be willing to pay a fair price for his trees and to do business with men who are known for their carefulness and integrity.



Fig. 45. A pond is often the most convenient water supply for making spray solutions. The cut shows arrangement of stock solution, and dilution tanks for making Bordeaux. With the modern gasoline power outfit, the elevated platform for gravity loading is unnecessary as the engine can pump the material into the spray tank

Age for Setting.—One or two year old trees should be set. In general, the younger the tree, the more easily it can be properly trained, the less shock it receives in transplanting and the more likely it is to live. Opinion is about equally divided among the best commercial growers, between one and two year trees. Either are all right when well grown. Older trees should not be used and the tendency is distinctly toward the yearlings.

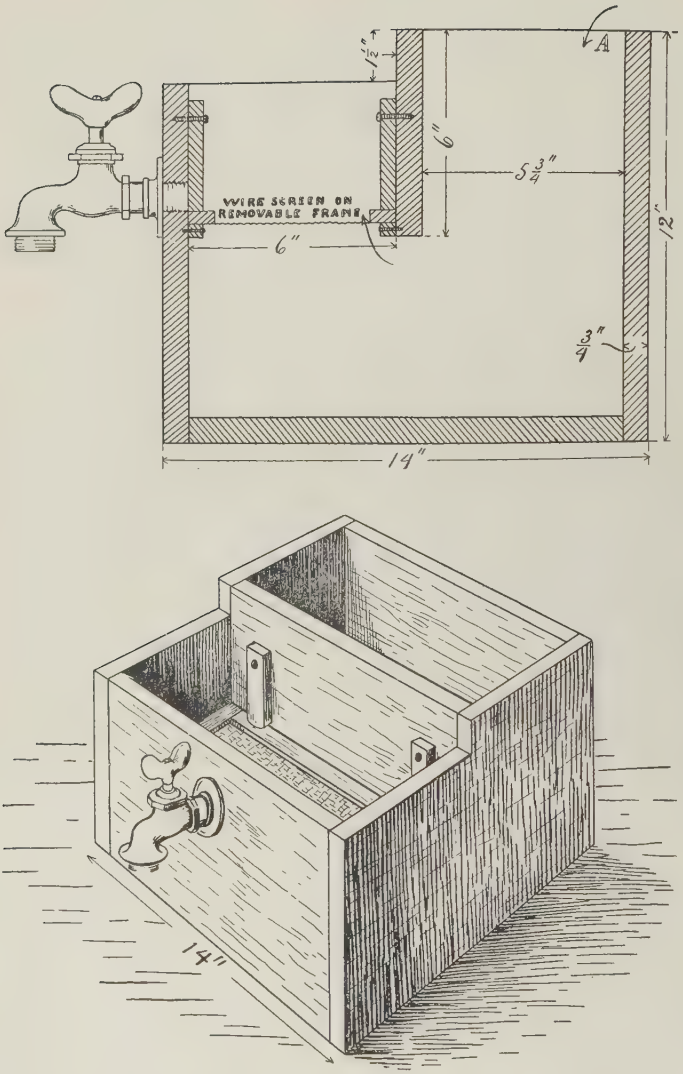


Fig. 46. Stewart's strainer. The sediment collects below the screen instead of on it and does not fill up the screen

Care of the Trees Before Setting.—As soon as the trees are received they should be unwrapped and heeled in. Most nurserymen attach printed instructions to the package of trees which, if carefully followed, would save much loss. If received in freezing weather, the bundles should not be opened at once but should be placed in a cool, damp place to thaw very gradually. Heeling in consists simply in digging a long trench and laying the trees in it in a slanting position, generally with the tops to the south. The earth is then thrown over the roots and worked thoroughly about them, firming it thoroughly during the process. A little loose earth



Fig. 47. Making concentrated lime-sulphur at home. With a simple outfit of kettles and brick furnace, enough material may be made in early spring for the whole summer's supply

on top helps to prevent drying. In this way the trees will keep without injury until ready to set.

Setting the Tree.—The details of setting trees will vary with the size of the orchard and the amount of help available. Some time may be saved by having the holes dug beforehand, especially in handling two-year old trees. The disadvantage of this lies in the drying-out of the earth which comes out of the hole and which must be put back about the roots of the tree. The important thing is to set the tree firmly, to set it in exactly the right place and to keep the roots from drying out during the process. In handling

a quantity of trees, puddling is resorted to to prevent drying. A hole is dug in a clayey spot about three feet in diameter and two to three feet deep. Enough water is poured in and mixed with earth to make a thin mud. As the trees are taken from the heeling in trench, the roots are plunged into the liquid mud, an armful of trees being taken at a time. The mud covers and coats the roots, and prevents them from drying, during the time the trees are unavoidably exposed to the air during setting.



Fig. 48. Equipment for making Bordeaux or lime-sulphur on a large scale. A traction engine is being utilized to cook the lime-sulphur with steam. Niagara gas sprayer shown loading at right

The roots may be pruned either before or after puddling, or if desired, at the time the trees are unpacked and heeled in. The necessary root pruning consists simply in cutting back all straggling roots, removal of broken, bruised or diseased roots, thinning of dense, fibrous masses and usually a shortening of the general root system by about a third; the latter operation depending on the amount of root development and the age of the tree. In any

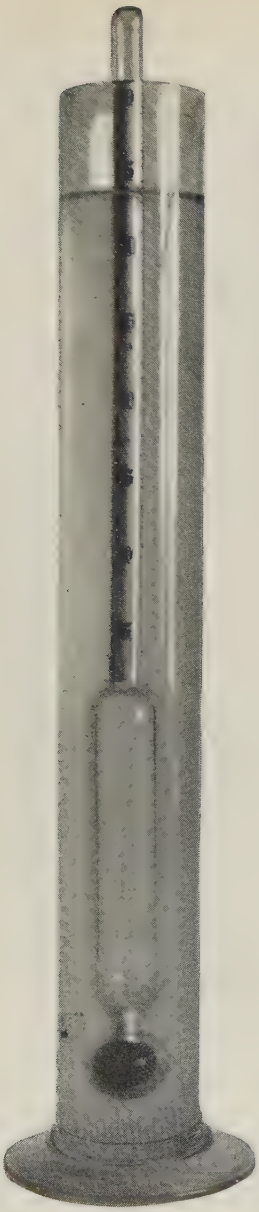


Fig. 49. Testing density of lime-sulphur in a glass meter. The reading shows a density of six degrees Baume

case a sharp lookout should be kept for evidences of crown gall and for the little grayish white, woolly masses which indicate the presence of woolly aphis. No trees affected with either of these pests should be planted.

The tree should be set slightly deeper than it stood in the nursery row. If exposed to the force of the wind, it is often good practice to lean the tree slightly in the direction of the prevailing wind, usually to the west or southwest. *Pack the earth firmly about the roots, especially under the crown of the tree,* where it is so easy to leave an air space. Be careful not to bruise and injure the roots by tramping while they are barely covered with earth. It is well to put the good top soil about the roots first, using the poorer soil from the bottom of the hole for the top. Leave a little loose earth at the surface to help prevent evaporation. (For discussion of the first pruning see page 63)

Planting Plans and Fillers.—The principal planting plans used in setting commercial orchards are the square, the hexagonal (sometimes called triangular) and the alternate (also sometimes called triangular), or various modifications of these plans which may be made by different methods of interplanting with fillers. These plans are illustrated in the diagram. (Fig. 2)

The square plan needs no explanation, consisting as it does of rows an equal distance apart with the trees the same distance apart in the rows. Its great advantages are simplicity of laying out, and ease and convenience of cultivation, spraying, harvesting, etc. The disadvantages often ascribed to it are that the trees do not occupy the ground economically, being farther apart on the diagonal than in the row lines.

The hexagonal plan requires that each tree be equally distant from all the surrounding trees. The plan presents a series of equilateral triangles with a tree at each apex. The ground is most economically used by this plan and the theoretically unoccupied ground is reduced to a minimum. Theoretically, or on a field of infinite extent, 15 per cent. more trees can be set per acre by the



Fig. 50. A good type of barrel pump

hexagonal plan than can be set in squares with the trees the same distance apart. On small or irregular areas this percentage of increase is considerably reduced. On account of the economy of space, perhaps, the hexagonal method of setting, finds its greatest popularity on the high priced fruit lands of the west. The disadvantages ascribed to this plan are greater difficulty of laying out, difficulty of thinning, and, on account of the narrow middles, greater inconvenience in all team work in the orchard.

The alternate plan is similar to the square except that the rows are staggered or jogged, so that trees in contiguous rows are not opposite.

The question of fillers will be considered by the orchardist in connection with the relative merits of different planting plans, and the decision as to which plan to be used is a matter of individual judgment. Considering the low price of most Indiana fruit lands, it is the opinion of the writers that the square or the alternate plans are usually preferable.

The question of fillers is one that must be left largely to the individual also. There is no valid objection to fillers if they are



Fig. 51. Barrel pump mounted in wagon with tower for reaching tops of trees, in use in a small orchard

removed when the permanent trees need the room. As a matter of common experience it is rarely indeed that the orchard owner will cut out fillers when they are bearing paying crops, yet this must usually be done for the sake of the longer life and the greater ultimate profit from the orchard. If the fillers are cut down at the first sign of overcrowding, well and good. They will usually pay a good profit before they go, and the permanent trees certainly do not need all the room for the first few years. In some cases the wisdom of using fillers is doubtful in a large orchard, simply because of the additional care and expense and labor during the first few years. Some commercial orchards do not at first have the most experienced

oversight. A man may be able with help to look after, protect, spray, prune, and care for 5000 trees set on 150 acres. If there are 10,000 trees on this same ground all may suffer. With experienced management, abundant labor and a first-class farm organization, this suggested objection is of no weight. In actual practice it is often of importance. In case the square plan is used for the permanent trees, the customary method of using fillers is to set them in the centers of the squares. If the permanent trees are set on the alternate plan with the intention of using fillers, the latter will be set in rows between the permanent trees as indicated in the diagram. (Fig. 2)



Fig. 52. Double acting horizontal pump connected with a 50 gallon barrel tank. This type of pump is more powerful than the barrel pump and is often used in a half round tank mounted on trucks

If fillers are used it is preferable that they be of the same kind of fruit as the permanent trees. In some cases peaches are used as fillers in the apple orchard but seldom with profit. The management of the two fruits differs at many points, and though theoretically possessed of many advantages, in actual practice the scheme seldom works out well. Early maturing varieties of apples may be used as fillers in the apple orchard, or if the main planting does not consist of late bearers there is no objection to using the same varieties for both temporary and permanent trees.

There are very few bearing commercial orchards in which the trees are not too close together. The permanent trees should not

be closer than 35 feet; on strong heavy soil 40 to 50 feet is still better. The latter distance will allow of fillers remaining for a number of years longer and will better justify their use than will the closer planting so often practiced.

Preparation of Soil.—The preparation of the orchard ground will depend somewhat on the system of orchard management to be practiced later. (For discussion of orchard management see page 73 and following) In general the better prepared the ground can be before the trees are set the better. If the setting is done in the fall and the orchard is to be managed after the clean-culture cover-



Fig. 53. Gasoline engine outfit. This type of sprayer will carry two or more leads of hose and is the best type for most commercial orchards

crop plan, the ground should be thoroughly worked during the early part of the season and should go into the winter protected by a cover-crop. Some early maturing cultivated crop such as early potatoes may be grown and followed by a quick growing cover-crop such as cow peas or soy beans. If the trees are set in the spring the ground should be broken early (fall plowing is often advisable where washing is not likely to occur) and thoroughly fitted by subsequent disking and harrowing. This thorough early cultivation pays and can be done more easily and cheaply before the trees are set than afterward.

If the orchard site is hilly so that cultivation is dangerous on account of the likelihood of washing, the mulch system of orchard

management is preferable and the problem of preparation for planting is somewhat different. In such a case it is wise to provide beforehand enough mulch material to mulch each tree thoroughly as soon as it is set. In a season of ordinary rainfall and on fairly good ground it is often possible to provide mulch material by cutting over the ground twice during the season and putting up all grass, weeds, etc., in small cocks or bunches to save until planting time. *Trees set in sod should be protected by a mulch from the start* whether they be set in fall or spring. This mulch should be heavy enough to kill out all the grass under it, and should cover an area not less than five feet across. If the ground itself cannot furnish enough material for a thorough first mulch, strawy manure, straw or other outside material may be used.



Fig. 54. A well in the orchard may furnish sufficient water for spraying purposes, and the engine on the sprayer may be used to fill the tank, obviating the necessity of elevated platforms

Young trees usually need protection from rabbits, mice, ground hogs, etc. This is especially necessary with trees set in sod and the protectors should be put on soon after planting. (See page 81)

The plan is sometimes followed of plowing strips on a hilly orchard site, setting the trees in the cultivated area and leaving strips of sod between to prevent washing. By this method the plowed strips follow the contour of the slope, and hence the plan is often designated as contour cultivation. If the ground is not too hilly and rocky, and if the cultivated strips are thoroughly well fitted and kept in condition, the plan has much to commend it. There are many profitable orchard sites where it is not practicable, however, and even where it might be a success, the cultivation is often so half hearted that the trees do not receive the advantage either of first rate culti-

vation or thorough mulching. If this plan is followed the preparation for setting the trees is the same as if all the land were under cultivation.

Planting Methods.—The planting methods followed depend on the system of orchard management, the size of the orchard, and the time of year it is set. If spring setting is made on properly fitted ground the rows may be laid off pretty accurately with a marker, the trees being set at the intersections and the small irregularities being corrected by sighting. If tall guide stakes are set about the borders of the tract, it is often possible to save consider-

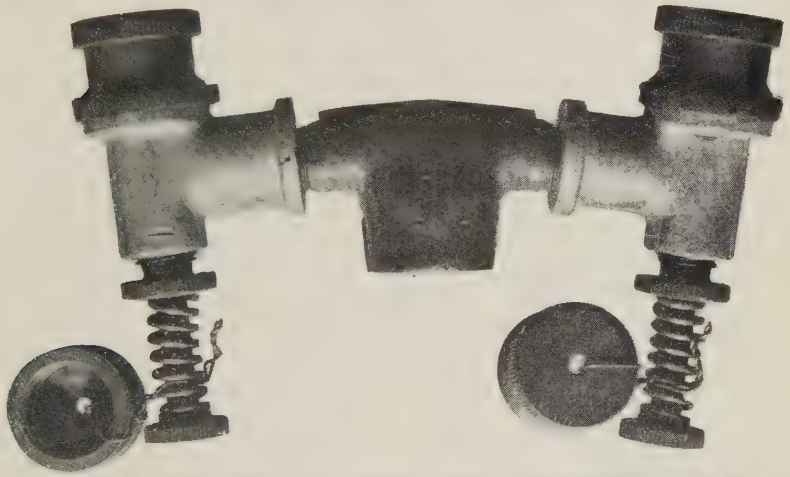


Fig. 55. Double Vermorel spraying nozzle. The attached caps are extras. This type of nozzle is widely used and is fairly satisfactory

able labor in digging by plowing a deep, straight furrow along the row. By sighting to the guide stakes the trees may be aligned in the other direction. If the orchard is to be set in sod the first few rows along one side may be staked out, tall guide stakes set at longer intervals and the trees may then be aligned in both directions by sighting as the setting progresses, no matter which planting plan be adopted.

A careful and efficient planting gang is necessary for good and rapid work. [1]"It should consist of four men. The first man prepares the trees for setting by separating them from the bunches and by pruning them with a pair of sharp pruning shears which he carries in his hip pocket." [2]"He then goes ahead of the other three men and drops a tree at each place. The duty of the second man is

[1] F. A. Waugh, "The American Apple Orchard," page 44

[2] Many growers prefer to prune the trees after setting rather than before. It is not always that the man who plants the tree knows enough to prune it. If the trees are set in the fall, the first pruning should be deferred until spring in any case.

The hand shears while rather more rapid, do not do quite as good a job of cutting as the old fashioned pruning knife in the hands of an expert. For the inexperienced, the hand shears are the safer (for the tree) tool to use

to hold the tree in position while it is being planted. The third and fourth men carry shovels and fill the soil in about the roots. It is the duty of the third and fourth men also to sight the tree into position. As soon as one tree is planted the second man walks forward to the next tree, picks it up and places it approximately in position. One of the shovelers, who has stayed behind for the purpose, sights forward down the row to bring the tree into line with the stakes. He then motions to the man who holds the tree until the alignment is secured. The other shoveler has meanwhile stepped to one side where he is able to sight down the line in the other direction and in like manner to indicate the cross-alignment for the man who holds the tree. As soon as the tree is placed in its proper position the two shovelers begin to fill in about the roots, one from one side of the furrow and one from the other. * * * When holes are to be dug by hand it is best to use sharp, square pointed, short-handled spades in hard ground, long-handled spades in medium ground and long-handled, round-pointed shovels in light, loose or stony ground. Of course different men have their own preferences in this respect, but they will not depart far from the rule here laid down. There are some special devices for digging the holes, usually more or less on the post-augur pattern, but, like patent farm gates, they are of little practical value."

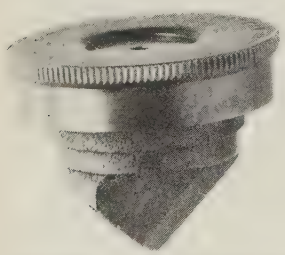


Fig. 56. The angle Friend type of spray nozzle. It is simple, compact and satisfactory. Cut shows natural size

The old fashioned planting board or planting jack is useful in setting a small orchard but is too time consuming for big jobs. It consists of a board about six feet long, notched on one side and at the ends. By its use, it is easy to set a tree in the exact place previously occupied by a stake, which will have been removed in digging the hole. The method of using this device is fully explained in Circular No. 17.

A device consisting of two wires and three rings is often used to get an accurate start in laying out an orchard for hexagonal planting. The wires and rings are fastened together as shown in Figure 3, the wire plus the diameter of the rings being equal in length to the distance between the trees. The first row is staked off along one side of the field. The free rings are then dropped over two stakes and the ring to which both wires are attached is drawn out as far as it will go. A stake through this ring, with the wires straight, indicates the position of a tree. In this way from any two stakes the position of a third can be quickly determined. After a few rows are set the balance may be located by sighting.

III.—PRUNING

The whole subject of pruning is a subject of perennial discussion among fruit growers. From the individual who regards pruning as a violent, unnatural and injurious process, to the most ardent advocate of severe heading in, all shades of opinion are represented. No two trees present quite the same problem; no two pruners have quite the same ideal of what a perfect tree ought to be, and too frequently no clear and well defined ideal of any sort is present in the mind. Pruning may be done for a number of different purposes. Hence it is not to be wondered at that opinions concerning this important orchard operation are various and apparently, at times, contradictory.

Some of the different pruning problems are discussed in the following pages. It will be easily seen how impossible it is to lay down a definite rule and to state that an apple tree should or should not always be pruned thus and so. It is the purpose of the discussion to present the matter in such a way, to make such suggestions and to formulate such principles as will enable the commercial fruit grower to correctly interpret his own pruning problems and solve them with a clear understanding of the issues involved and the ends to be attained.

The Young Tree—Initial Pruning.—The first pruning which the young tree usually receives, is, strictly speaking, that which is involuntarily given the roots in the nursery row at the time the tree is dug. It is practically impossible to lift the entire root system. It is also unnecessary. The fine feeding rootlets of the tree generally have to be developed again after the tree is set in the new surroundings. It is seldom or never under ordinary orchard conditions that these portions of the root system are not destroyed in the interval between digging and resetting.

When the tree is set then, the root system is not at once ready to furnish from the soil a full and abundant supply of moisture. Unless the leaf bearing wood of the top is reduced to the point where the temporarily crippled root system can supply the needed moisture, disaster is inevitable. A severe initial pruning is necessary then to "restore the balance," between the moisture transpiring ability of the top and the moisture gathering ability of the roots.

If the trees are set in the fall, experience has shown that it is generally best to defer this first pruning till spring. If fall set trees are pruned at once, they are likely to winter kill back several inches from the cut tips, and may be seriously and permanently injured thereby. With spring set trees, the sooner the pruning is done the better.

Another object of the first pruning of the young trees is to shape the top. On a quantity of fine two-year Akin, set the past spring at the Station, nearly every tree had two long, heavy leaders springing from the same point. In each case unless one of these was removed entirely a bad crotch would have been the inevitable result. Opinions vary as to the precise amount to remove from the head of the young tree. The writers advocate the sort of pruning shown in Figures 4, 5 and 6, which show newly set two-year trees before and after cutting back. Two to five buds are left on a

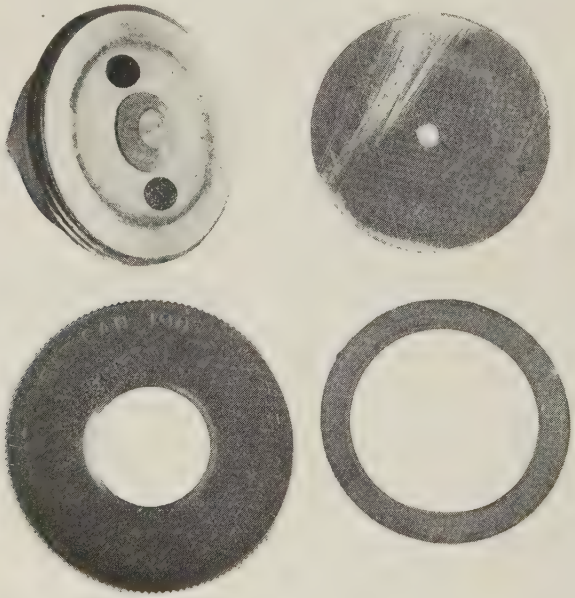


Fig. 57. Showing all parts of nozzle shown in preceding figure. There is little to get out of order. The steel disk (upper right) fits inside the brass cap (lower left) is held snug by the rubber gasket (lower right) and the whole screwed on base (upper left)

branch. Usually it is necessary to remove entirely quite a number of branches which would soon crowd if left. Linear growth in the young tree takes place at the tip. The height of the first limb from the ground or the distance between two branches on the trunk, does not increase as the tree grows. Rather the branches get closer together by their growth in diameter. Hence the height of the head is practically determined at the first pruning.

The trees in the commercial orchard should be low headed. The

old controversy over the relative merits of low headed and high headed trees is about extinct. The low head, starting from 18 to 30 inches from the ground is to be preferred, being easier to prune and spray and cheaper to pick fruit from, than the old fashioned high head, which started from four to six feet from the ground. It has been well said that the trunk of the fruit tree is mostly waste.

From three to five main branches should be left to form the scaffold or supporting limbs for the top. These should be as well distributed around the trunk as possible, and should also be distributed through as much vertical distance as possible, in order to make a strongly supported top.

If convenient in pruning the top, it is well to cut to an outside bud, to encourage the spreading habit. This point, while well to bear in mind does not deserve the importance often attached to it, since the modification of the direction of growth is relatively slight at best, the new growth tending strongly to continue in the direction previously started, and tending also to the characteristic form of the tree. Whether upright or spreading the effect of the wind is also important in determining the direction of new growth. We cannot force an Akin to grow like a Winesap by cutting to an outside bud, although we may correct the close, upright growing habit to some extent by persistent selection of outside buds.

If one year old trees are set the pruning is usually a simple matter, and consists merely of a heading back of the top usually about a third. The weaker the growth the more severely the tree should be cut back. If twin leaders have developed one should be removed entirely to prevent the forming of a bad crotch later.

The Young Tree—Second Year.—Under favorable conditions the newly set tree will make a rapid growth during the first season. The trees should be gone over after the first season's growth and the tops thinned out. Usually a number of branches are started which are growing in the wrong direction, which cross and interfere with each other, and which need to be cut out. The illustrations (Figs. 7, 8 and 9) tell the story. These are drawn from photographs and represent actual trees and real pruning and are consequently none of them quite ideal. The principle, nevertheless, is sufficiently illustrated. The heading in of two-year and three-year old trees is a matter about which various opinions are held, some contending that the heading in and thinning of over crowded growth in the young tree stimulates further wood growth at the expense of early bearing. If carried to excess it probably has some effect in this direction. The fact must not be overlooked, however, that during the first two years after setting is the only time to make a well shaped, strong and symmetrical foundation for the future growth

of the top. It is the easiest time to correct ill formed heads before the tree is so far along as to be past training. A judicious heading in of long upright and lateral branches will make the young tree more stocky and will encourage the development of more lateral branches from the leaders, giving greater opportunity for future selection and for the forming of a satisfactory head. If the trees are allowed to grow after the initial pruning without heading back, several leaders are likely to arise and make the undesirable kind of top as shown in Figure 10.

The third and fourth seasons' pruning will be limited to the removal of crowding and crossing branches and to the heading in of any particularly long shoots.

If the pyramidal form of top is desired, or as it is sometimes called, the "two-story tree," the treatment from the first pruning on will be slightly different. A strong leader will be allowed to develop after the initial pruning. This will be headed in but slightly. Lateral branches will be allowed to develop from this leader, in a second whorl, somewhat as if the leader were the original trunk and the laterals the original scaffold limbs. These should be distributed through as much vertical distance as possible and are treated otherwise as any other part of the tree, care being taken to prevent crossing, etc.

Pruning the Mature Tree.—The feeling that pruning is an unnatural process, inherently injurious to the tree, at best a necessary evil and to be done as little as possible is often expressed by orchardists who should know better, and is the excuse often offered by the more indifferent for neglect. Pruning of the mature tree is an unnatural and artificial process in the same way that surgery is artificial. The production of large and regular crops of highly colored, fine flavored, sound apples is not natural. It is distinctly artificial. The natural crop is found in the gnarled, dwarfed product of our neglected orchards where nature holds full sway, or in the inedible harvest of the native crabs of this and other countries. Nature's method is the extravagant and wasteful method of natural selection and unlimited competition, where the least fit are exterminated and the kind of life most fit for the struggle is alone allowed to survive. From nature's viewpoint, the codling moth, the scale and the fungus are as much entitled to life as the apple tree. In this competition the perpetuation of the species is the paramount object. The apple tree which produces the most seeds is most likely to survive. Man's object is the elimination of competition and the production of size, flavor and color, not seeds. His method is artificial in every orchard operation from the propagation of the tree to the protection of the crop from its "natural" enemies by means of



Fig. 58. A neglected sod orchard rather better than the average, which presents an excellent opportunity for profitable renewal

spraying. In this sense pruning is not "natural," yet it is essential to the health and longevity of the trees and is necessary to the production of desirable crops. Some orchardists succeed in a measure and neglect pruning. Their success is due to the excellence of their artificial care in other directions, however, and is attained in spite of, not because of, their neglect of intelligent care in this direction.

The keynote of the pruning of the mature tree lies in the point of view which looks upon the tree, not as an individual, but as an aggregation, a community. Strictly speaking, the bud is the individual, the unit. The vast number of living buds of a mature tree are competitors, not partners. The small shoots on a branch are competitors, the larger branches themselves are competitors for light, and air and room to grow. It is the business of the pruner to decide on those branches best fitted to survive, and then to relieve them so far as possible from the injurious competition of their neighbors.

An annual light pruning is most desirable.

This annual pruning either with young trees or old is best done just before growth starts in spring. In large orchards the work may begin in the mild days of February. Like most other guides to horticultural practice, modification of this rule is possible. Under special conditions it may be expedient to begin earlier and take advantage of the favorable days from New Year's on; or it may be advisable to prune up to the middle of May, and it can be done without disaster. It is not advisable to leave the wounds exposed to frost and drying if it may be avoided. The pruning should be done at such a season that healing may begin as soon as possible.

The pruning in a mature orchard is never finished. There is some to do each year. The trees are growing, branches are continually beginning to crowd and some are ready to come out at the end of each winter. The statement is sometimes made that a skillful orchardist will never have to use anything larger than a pocket knife for his pruning, meaning that the development of undesirable growth will be so foreseen that branches which are ever to come out, will be removed before they get too large to be cut with a pocket knife. Such a prevision and judgment might be developed by sufficient study and experience, but could not be exercised if the orchardist so endowed had more than a dozen trees to prune. In commercial orchards there are always some good sized limbs to cut out as well as small ones.

The general object of the annual pruning of the orchard is the promotion of regular bearing, steady, uniform growth and the avoiding of over crowding. If pruning is neglected for a few years and all done at once the trees are thrown out of balance, wood

growth is over stimulated in the tree's effort to restore the balance between top and roots, water sprouts develop and bearing is interfered with. The pruning of the neglected tree presents some special problems discussed under "Renewal of Old Orchards," page 102.

Pruning for Special Purposes.—Outside of the routine pruning, for the purposes above discussed, there are certain special cases where pruning may be resorted to with other objects in view.

Pruning is sometimes done in summer to induce bearing. A summer heading in of trees which are making a heavy wood growth and are not bearing, checks the growth of the tree and is likely to induce the formation of fruit buds. Seeding down the cultivated orchard often has the same effect. Girdling is sometimes practiced to determine if the tree needs a check in its growth to induce it to bear. A strip of bark two to three inches wide is removed entirely around the limb, in May. The wound should be protected with grafting wax. This operation may be performed upon two or three of the branches of a tree in an experimental way and the result the succeeding season will sometimes give the cue as to the treatment needed for the orchard. It is not practicable on a large scale.

Pruning is useful in helping to hold diseases in check. This is especially true of the fire blight, and to a considerable extent of bitter rot and black rot as well. All these diseases cause cankers of one sort or another in the bark. Cankered limbs should be cut out. If this is not feasible the canker itself should be cut out, removing all the dead wood from the margin of the canker so that a natural and healthy callous may be thrown out from the sound wood left. The cankered area should then be painted over with a coat of thick paint made with white lead and raw linseed oil. In fighting fire blight it is necessary also to cut off and burn the blighted tips. The fire blight is a bacterial disease and the infection may readily be spread by the pruning tools. Hence it becomes necessary to disinfect them after each cutting operation. This may easily be done by wiping with a swab saturated in kerosene, a bottle of which is carried for the purpose. Seeding down the orchard if it is in cultivation, and thus checking the growth of the trees, and causing them to ripen their wood more thoroughly, makes them more resistant to blight and is often of great service in stamping out the disease.

Pruning Tools.—In order to make the work of pruning inexpensive and efficient as well as to reduce the labor, it is necessary that the fruit grower be provided with an adequate outfit of high grade pruning tools. The outfit for the commercial apple grower will consist of hand shears, saws, pole shears and lopping shears. Many prefer the old fashioned, hook bladed pruning knife for work-



Fig. 59. A typical starved orchard. The land has been cropped, or mowed for hay for years, no fertilizer has been applied, yet the trees are fairly healthy, though stunted, and will respond surprisingly to proper treatment

ing about young trees, as noted on page 62. Occasionally an axe, either long or short handled, will come into play as an accessory tool for cutting large limbs. It is sometimes easier and quicker to cut off a large branch with the axe, leaving a stub a foot or two long, which is removed with the saw immediately afterward, without danger of splitting, than it is to do all the work with a saw. The pruning saw is the most important tool in the kit. Excellent types are shown in Figures 12 and 13. The swivel blade is often a great convenience. Also extra blades may be kept on hand and a dull one may be quickly replaced without the necessity of immediate setting. The straight saw shown in Figure 14 is also an excellent tool. Various other types are on the market, some curved, some with the teeth so set as to cut on the pulling, instead of the pushing stroke and some with teeth on both sides of the blade. The general objection to the latter type is inconvenience in close work, the upper side of the saw damaging a branch which is not to be taken out, while the other cutting side is working. The curved type has its advocates, but the two shown in Figures 12 and 13 will be found to answer most requirements. A carpenter's cross cut saw of medium size and having considerable taper will be found very convenient and rapid for such work as it can be used for. The hand shears should be of a heavy grade, the nine inch size being generally preferable. It doesn't pay to get the 50 cent hand shears which are generally offered as the material is not of the best and they soon wear out. The types shown in Figures 15 and 16 are the best. Those shown in Figures 17 and 18 are not desirable. The lopping shear is sometimes convenient for certain kinds of work but is probably the least essential tool in the outfit, since almost as rapid work can be done if the saw is used for branches which are too large for the heavy hand shears, and with the saw a closer cut and cleaner wound can be made than is possible with the lopper. The pole shear finds its chief use in thinning young shoots from the top, in cutting out tips killed by fire blight, etc. The type in which there is one cutting blade, operated by a lever attached to a heavy wire, running to a second lever operated by the hand, is preferable to either the double bladed sorts or to those in which the power is transferred by a rope instead of a wire. There are a number of other satisfactory types, among them being one which is similar to that described except that the secondary lever at the hand, is dispensed with and the shears are opened by a spring.

How to Do the Work.—All cuts should be *close* and *clean* and the surface of the wound should be parallel to the direction of the branch on which it is located. Branches should be cut as close as possible without getting into the surface of the branch from

which they spring. Shoulders such as that shown in Figures 19 and 20 should not be left. Stubs must not be left. They cannot heal over, and as they decay they give entrance to rot producing fungi to the body of the tree, shortening its life and weakening its resistance to wind and storm. In removing branches of any considerable size with the saw, start the cut on the under side. Then saw through from above and the branch will fall without splitting and tearing



Fig. 60. Plowing the old orchard. This is one of the first and most important renewal measures. The orchard plot should be cultivated as well as the corn field

a strip of bark from the wound. Wounds left by branches over an inch and a half in diameter should be painted. The larger the wound the more necessary such protection will be. A thick paint made of white lead and raw linseed oil is very good for this purpose and is not expensive. The purpose of the protection is to keep out rot, to prevent moisture from getting in and by this means to promote the rapid healing over of the wound and its natural and permanent sealing up by the callous tissue which the tree throws out.

IV.—ORCHARD MANAGEMENT

There are a number of problems having to do with the successful management of the commercial orchard through a term of years, which are of great importance to the fruit grower. Some of these problems are mentioned in the following discussion. Orchard conditions are so diverse in different parts of the state that no one plan of management will always be suitable. Orchard practice on the other hand is not yet sufficiently crystallized in many respects to admit of dogmatic statement as to what is best and what second best. The effort in the following discussion has been simply to set forth the nature of the problem and to indicate the directions along which the individual orchardist may safely proceed in developing his own judgment.

Sod and Sod Mulch vs. Clean Culture with Cover Crops. The relative merits of the various systems of orchard management grouped under the above terms have been the subject of a great amount of controversy in recent years, among both fruit growers and investigators and several experiments are now in progress and have been already reported on in a preliminary way, which are designed to throw more light on the problems involved.

One of the principal objects in every system of soil management in the commercial orchard is to save for the use of the trees, as large a proportion as possible of the rainfall; another object is to add to or to make more available the original content of plant food in the soil. Advocates of both sod mulch and clean culture with cover crops have claimed that these fundamental objects were attained to a greater degree or with less expense under each of their respective methods. A general loose use of the various descriptive terms has added to the apparent conflict in opinion. In different sections of the country different meanings have been attached to the same term; thus sod-mulch in the press discussions and even in station bulletins has stood for quite a variety of orchard management methods.

It is unquestionable that good fruit is being and has been produced and that under some conditions paying orchards are being maintained without systematic cultivation. There are many orchard sites especially in the more hilly sections of the southern part of the state which scarcely would permit of cultivation. Such lands should not be broken and need never be cultivated and yet may support excellent orchards.

Orchards which are so rolling that the soil would be liable to wash badly, may be successfully managed under the *mulch* system. The term "sod-mulch" is rather unfortunate. Too often it con-

veys the impression that the orchard is simply left in sod of some sort and the vegetation occasionally cut and perhaps taken off for hay. Even in the so called "Hitchings system" as defined and practiced by Mr. Grant Hitchings, of Onodaga county, New York, a leading advocate of "sod-mulch," the trees for the first few years after setting are quite thoroughly mulched, and for this purpose, Mr. Hitchings prefers manure, thus furnishing not only mulch but fertilizer. A thorough and constantly maintained mulch of proper material will probably check evaporation of soil moisture to a degree comparable to that to which it is checked by a well maintained dust mulch, produced by cultivation. The majority of mature sod orchards, however, would be better off under cultivation with cover crops, for the reason that the grass furnished by the orchard soil is not sufficient to make a mulch which is heavy enough to compare, in its prevention of evaporation, with thorough cultivation. On some steep orchard land which the writers have had under observation for the last two years, a season's cutting furnished scarcely enough mulch for newly planted trees set 35 feet apart each way. Experiments made by the Geneva Station indicated that the soil of a cultivated orchard plot a few inches from the surface contained more moisture than the soil in a sod mulch plot even when the latter grew sufficient grass to make two tons per acre when cut, this grass being used for mulch and allowed to lie where it fell when cut. The great disadvantage of the mulch system for mature orchards is the difficulty of obtaining a sufficient supply of mulch material. With trees far apart on strong land, a sufficient quantity of mulch material may be grown during the first few years after setting, to make, when collected and put immediately about the trees, a mulch which will be adequate to its trees' needs. As the trees grow and demand a larger circle of mulch, and as the producing area is correspondingly diminished the growing of sufficient mulch material in the orchard becomes increasingly difficult until it is impossible. The eventual expediency of the mulch method, then, except for use by necessity on the steeper slopes, depends upon a cheap and accessible supply of outside material. In some sections of Indiana at the present time it is possible to secure straw in sufficient quantity and at a low enough price to justify its use as an orchard mulch. Small grain fields may be cut over with a mowing machine a few weeks after harvest and a large quantity of weeds and stubble secured which makes excellent mulch. Corn stover is sometimes tried but it is too coarse and does not pack closely enough to be desirable mulch material.

In most localities the providing of mulch material for a large orchard other than that grown between the orchard trees, is an im-

practicable proposition. This means that in most commercial orchards, except for such parts as may be too steep, clean cultivation with cover crops is the system of orchard management which will produce the best results. The clean-culture cover-crop system involves clean and continuous tillage from the time the ground can be worked in spring until the season is well advanced. Cultivation then ceases and a crop called a cover crop, is put in the land. This crop remains on the ground during the late summer, fall and winter. *It is not harvested.* The following spring the cover crop is turned under and clean cultivation resumed until mid-season, to be followed by another cover crop and so on each season. The exact time for stopping cultivation and for putting in the cover crop depends on the season, the crop and the locality. For the northern part of the state an average time for seeding is from the first to the middle of July; for the southern part of the state from the middle of July until the first of August. If oats or rye are used as cover crops, they may be put in somewhat later.

These dates of course are only approximate. The cover crop should be put in if possible after a rain in order to get a prompt and vigorous start. The condition of the ground with respect to moisture, as well as other weather conditions affecting the cover crop, will have an important effect in determining the precise time it shall go in.

The clean cultivation during the early part of the season sets free available plant food, improves the physical condition of the soil, *conserves moisture*, kills weeds and incidentally makes a seed bed for the cover crop. The trees usually make most of their season's growth quite early. If they are cultivated too late in the season they may be stimulated to make too late a wood growth which fails to properly mature and harden before cold weather and hence may be subject to winter killing. By stopping tillage and putting in a cover crop, the late growth is discouraged and the season's growth being made early is better matured and is less likely to winter kill. In addition to this effect, which is brought partly by the cover crop using up the soil moisture instead of the trees using it, a cover crop is of direct benefit in many other directions. It takes up a certain amount of soluble plant food and prevents it from being leached away by the winter rains. The cover crop holds the snow and prevents deep freezing, and what is more important especially with young trees, it prevents to a large extent the alternate freezing and thawing of the ground which is likely to work injury. When turned under in the spring the cover crop adds organic matter to the soil and thus improves its physical condition and moisture

holding ability. If leguminous crops are used there is another direct benefit in the additions of nitrogen.

Cover Crops to Use.—A number of different crops are used as covers, including oats, rye, cow peas, soy beans, crimson clover, winter vetch, field peas and occasionally corn, rape, turnips and rutabagas. These are used not only alone but in various combinations with each other. The crop to use depends largely on locality, soil, and price of seed, although it is by no means good policy always to use the cheapest. In general the leguminous crops such as peas, beans, vetch and clover should be used in the apple orchard unless the soil is unusually rich and the trees are making an excessive wood growth.



Fig. 61. If the old orchard is not worth caring for properly, cut it down and use it for firewood. Don't let it breed pests for the neighboring orchards

Crimson clover may make an ideal cover crop, but it does not do well on poor soil and needs to have a well prepared seed bed. Information as to its behavior in Indiana orchards is meager. An excellent stand was secured in the Station plum orchard in 1910, the seed being sown broadcast August 15 at the rate of 12 pounds per acre and covered lightly with a weeder. A close, even growth was made before winter, which was continued early in the spring. By the time it was turned under the plants were nearly a foot high.

It is generally regarded as an uncertain crop in the north, but has been used with success in northern Indiana and southern Michigan. 1910 quotations were from $12 to $16 per 100 pounds or from $7.20 to $9.60 per bushel.

Soy beans and cow peas are probably the best legumes for the greater part of Indiana, thriving especially well in the south. Both are killed by frost. Four to five pecks per acre should be used. In the northern part of the state it is perhaps preferable to use northern grown seed. Cow peas and oats are sometimes used together at the rate of a bushel each per acre. Drilling in of these crops is to be preferred to broad-casting. At the Station we generally use a two horse wheat drill set at five bushels per acre, allowing every hoe to run. The seed should be covered to get a good start and as is true of any other crop, they do much better on a thoroughly fitted, than on a half prepared seed bed. Prices vary from $2.50 to $4 per bushel.

Oats alone are sometimes used, if leguminous cover crops have been already put in for several years and if the wood growth of the trees is so heavy as to indicate that the soil needs no more nitrogen. If seeded thickly they make a good cover, freezing down of course in winter. They may be put in rather later than the crops before mentioned and may be either drilled or broadcast. They are generally used at the rate of one and one half to two and one half bushels per acre.

Rye is not generally desirable to use for a cover crop if the ground is in such condition that some of the better crops will succeed. Rye of course, has the advantage of extreme hardiness. It will grow late in the fall and will start early in the spring. Unless put in pretty late, it is apt to be too large when turned under in the spring to decompose readily in the soil. If it is at all strawy it tends to dry out the soil. If used it should be at the rate of a bushel to a bushel and a half per acre.

Winter or hairy vetch (Vicia villosa) is a good legume for the north. It is hardy and in some localities it has escaped and become a serious weed about the farm. It generally does best on light soils rather than on heavy clay. The seed is sometimes difficult to procure and is usually somewhat expensive. The 1910 quotations were from $8 to $10.50 per 100 pounds. It is used at the rate of about one bushel per acre. It seems to be increasing in popularity and will probably come into more common use.

Canada field peas either alone or in combination with oats are sometimes used and may make an excellent cover crop in northern Indiana. Alone they may be used at the rate of one and a half to

two bushels per acre. Quotations during the summer of 1910 were from $1.50 to $2.25 per bushel.

Other mixtures which have been used with success in different sections are:—[1] Buckwheat, one and one-half bushels per acre; field peas, one bushel (for clay soils); crimson clover, 12 pounds; oats, three pecks; vetch, one bushel; oats, one bushel.

Double Cropping.—Another question of orchard management which is frequently of much concern to the fruit grower is the question of double cropping or the growing of other crops between the fruit trees, especially while they are small and are not using all the ground. This matter, like the question of fillers is one which depends very largely on the local conditions and on the individuality of the fruit grower. On land which is rough so that the clean cultivation which would be necessary for the companion crop would be dangerous, double cropping is of course out of the question. On cheap land, some distance from market, double cropping is seldom advisable. This condition is typical of much of the southern Indiana hilly orchard land where a haul of from one to five miles is necessary to the loading station and then a rail transportation to a more or less distant market. Where the owner is not giving the orchard his own close personal attention, but is relying more or less on tenants or employees, it seldom pays to complicate the orchard problem by the introduction of a plan of companion cropping. Any kind of double cropping which involves the use of grain in the orchard, is liable to be especially dangerous to the young trees. There are circumstances, however, where double cropping may not only be not injurious, but where it may be profitable and desirable. Where the ground is rich and nearly level and where the owner himself is looking after the proposition, farm crops may profitably be grown under certain circumstances for a few years after the trees are set, and if properly regulated, the trees may not be noticeably injured by the intercropping. The main thing for the owner to remember, is that the orchard is the main and the important thing, and that the value of a single crop from a single 25-year old tree which has been thoroughly well grown may be worth as much as a 30-bushel yield of wheat from an acre of ground. Companion or double cropping again may often be successfully practiced near cities, where the land is too valuable to lie unproductive until the trees produce an income and where there is a good local demand for the small fruits or market garden produce that may be grown between the young trees and a good supply of the transient labor needed in harvesting.

[1] Cyclopedia of American Horticulture. L. H. Bailey, Editor

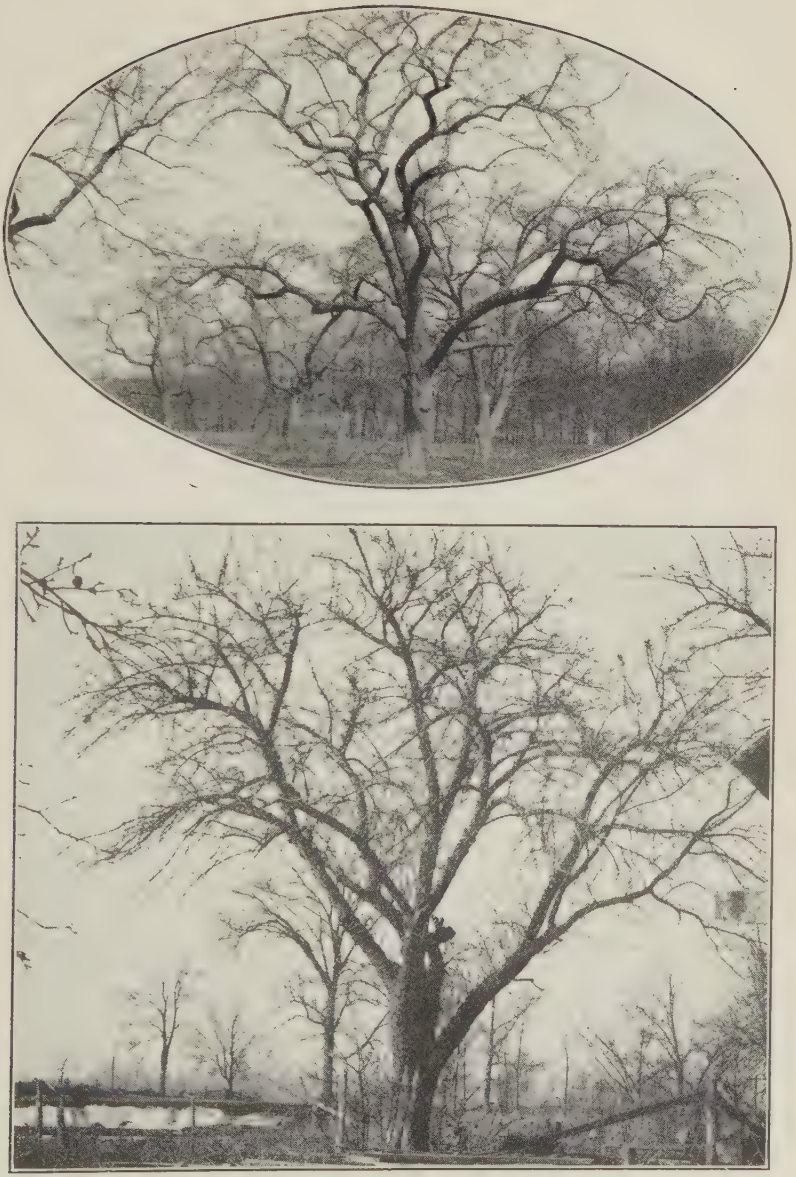


Fig. 62. These old trees bear the marks of a generation of neglect, but by heavy pruning, spraying and fertilizing may still be made profitable

Grain crops should be grown very sparingly in the young orchard. The small grains, such as wheat and oats, are especially bad for the trees and remove from the soil the very elements that the trees will later need to produce good crops of fruit. If such crops are grown, the plant food they remove should be refunded to the orchard soil in the form of commercial fertilizers, manure and nitrogenous and humus-supplying cover crops. In no case should grain be allowed to grow within six feet of the newly set tree. After a year, the space should be enlarged to eight feet and for the tree set two years, a free, cultivated or mulched space of 10 feet in diameter should be left. With these precautions, small grains may be grown without serious injury to the young trees, for two or three years. Corn is not so bad as wheat, but it likewise should not be allowed to come within several feet of the young tree. Corn takes from the soil an immense amount of moisture as well as considerable plant food and hence is especially dangerous to the young tree. A single, well-grown tree may be worth several acres of corn, so that it is poor economy to seriously endanger the future welfare of the newly set orchard for one or two crops of grain.

Other crops are better. Potatoes make an excellent crop for the young orchard. Their cultivation is just what the trees need; they do not remove from the soil so much plant food as the grain crop and they leave the soil loose and in excellent condition. Early potatoes especially, may come off in time to allow the putting in of a cover crop for winter protection.

Market garden crops in general, hoed crops, vegetables and the like are the best class of crops for growing in the young orchard. It is seldom that the orchard soil is rich enough to be most profitable for the intensive cropping of the gardener, however, and only occasionally that the right local conditions as to soil, markets, men, etc., meet to make gardening in the young orchard a practicable proposition. The scheme has many good things about it, though, and is sometimes worked out very nicely.

The small fruits are sometimes grown between the trees while the orchard is young. Of the small fruits, the strawberry is probably better adapted for this purpose than any other. It is a low grower, requires cultivation the first season, is mulched during the winter (the mulch having practically the same effect in the orchard as a good cover crop would have); the bed runs out in a couple of years or so, and so is likely to be out of the way by the time the trees need the soil and altogether has many factors to commend it. Sometimes the bush fruits are grown in the young orchard. The plan can be made successful with the right local conditions and

above all with the *right* man to run it, but is not to be especially recommended as a general proposition.

Tree Protectors.—It is often necessary to protect young trees from the attacks of mice, rabbits and ground hogs or woodchucks, any of which animals may kill the young trees by gnawing the bark. Injury is most likely to occur during the winter and young trees set in sod are especially liable to damage from rodents, since the sod and the mulch about the trees offer protection to mice and rabbits.

For rabbits there are a number of repellant washes which are fairly effective for a short time. Among them are the following: (1) blood or entrails smeared on the trunk of the tree, effective until washed off; (2) a mixture of tallow and tobacco smeared on the trunk; (3) whitewash made by slaking fresh lime with soapsuds; ("[1]when one peck of lime is used, add, while hot ½ gallon crude carbolic acid, ½ gallon gas tar and four pounds of sulphur. Stir well. For summer use, leave gas tar out and add in place of it one gallon soft soap"); (4) commercial aloes one pound to four gallons of water, sprayed or painted on the tree trunks; (5) lime-sulphur wash at the strength used as a winter application for San Jose scale.

These remedies are all more or less effective for rabbits until weathered off. For mice they are not so trustworthy. Keeping grass and weeds from growing up to the trunk and especially from collecting immediately about it, will obviate injury from mice to a considerable extent. This is not incompatible with the maintenance of a mulch about the trees on a hill-side orchard. In winter the mice are most likely to work on the trees immediately after a fall of snow, hence keeping the snow tramped down about the trunks is a useful preventive measure.

None of the foregoing methods of control are so effective as a good mechanical tree protector. The best of these is made of wire cloth, four meshes to the inch, and is shown in position about the young tree in Figure 30. The cloth may be bought through hardware dealers and comes in hundred foot rolls. It may be cut into foot lengths with tinners' shears and every foot long piece rolled into a cylinder about four inches in diameter. The selvage edge is generally put uppermost when the protector is placed about the tree. If well rolled it is hardly necessary to fasten the edges together, though this may be done rapidly by using hog rings and a ringing tool or by bending the free ends back and hooking them by the use of pliers.

[1] Horticulturist's Rule Book. L. H. Bailey

Care must be taken in using wire protectors about newly set trees, that they do not freeze into the soil and become rigid, and then cut the bark on the trunk of the young tree when it may rub the sharp wires during high winds. The selvage edge is less likely to cause damage than the free cut ends of wire, which are sometimes allowed to be uppermost. This type of protector while somewhat more expensive than some others is enough better to justify the greater initial investment.

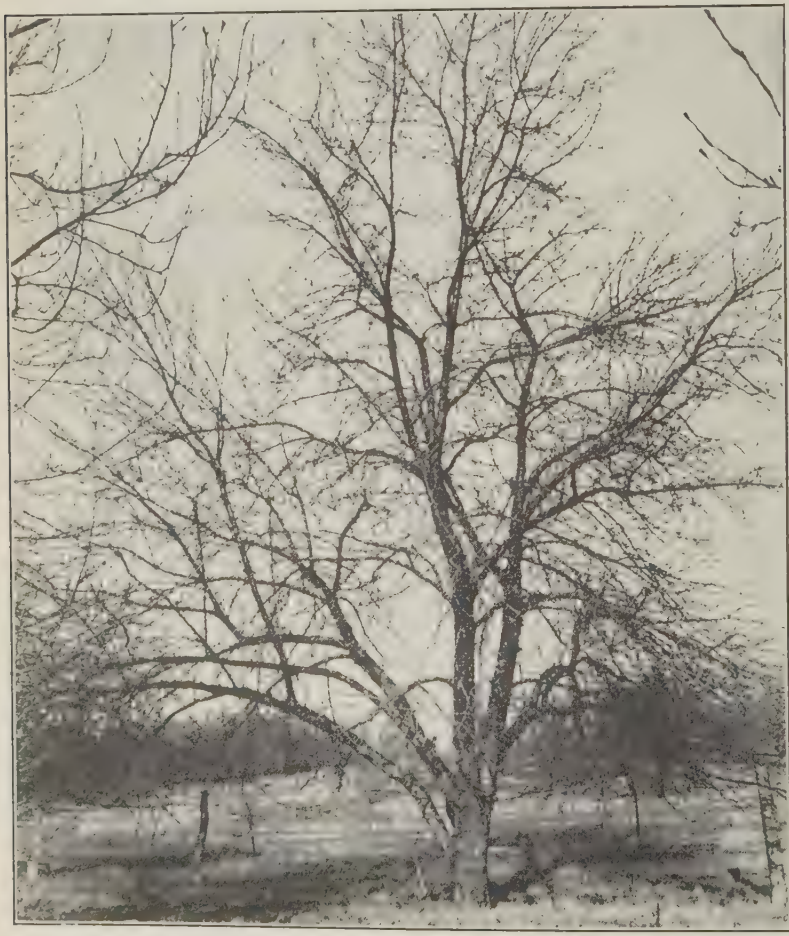


Fig. 63. A tree of the sky-scraper type. The thing most needed here is "dehorning," or such pruning as will bring the top down low enough to be sprayed

Wood veneer protectors are sometimes used. They must be soaked before putting about the tree and are likely to split when removed. Any tight, light and air-excluding protector of this sort should be left about the trees only during the winter, otherwise they are sure to become a nuisance and a harbor for woolly aphis or other insect pests.

Building paper is sometimes used. It may be bought by the roll and put on in the form of a cylinder, tied by a spirally wrapped twine or it "may be cut into strips from four to six inches wide and wrapped spirally about the stem to the desired height, beginning at the base and fastened with twine in the usual way. There are two points of superiority in the plan of spiral wrapping, over the cylindrical protector, first a crooked bodied tree can be closely and neatly covered; second, the spiral wrapper is more resistant to the strong winds of winter which sometimes play havoc even with building paper protectors if not securely fastened with twine spirally applied."

Mounding of the trunks of the young trees with soil to a height of four to six inches is also good protection against rodent attack. It is also often practiced on such orchard sites as may be likely to allow water to stand and freeze about the crowns of the trees. This should never be allowed. The insurance against this danger and the additional protection from mice make mounding often worth while.

Harvesting.—The subject of harvesting, packing and marketing the apple crop can only be barely touched on in this circular. An adequate treatment of all the problems involved would demand a book.

The fruit should be fairly well colored when picked and the stem should separate easily from the spur. Generally the brown color of the seeds indicates picking time, though this is not always a reliable guide. Either for immediate marketing or for storage the fruit should be mature. Neither immature nor over ripe fruit keeps well in storage.

Various contrivances are used in picking to prevent bruising. The greatest care must be exercised in this respect if the fruit is expected to keep. Every bruise causes the fruit to go down just so much earlier. The canvas or canvas and metal picking sacks, held open with a stiff wire hoop at the top and provided with a drop bottom to avoid pouring are coming into considerable favor. Careful workmen and careful supervision are both necessary if the picking is properly done. It usually pays to hire pickers by the day rather than by the barrel.

[1] Bulletin No. 208. Ohio Agricultural Experiment Station

Packing.—The fancy apples from the west and northwest are packed exclusively in boxes. The hundred quart barrel has been generally recognized as the commercial package in the east. This is 17¼ inches in diameter at the top, 64 inches in circumference at the middle and has a stave length of 28½ inches. The "Standard" apple box of the northwest is 10½ inches × 11½ inches × 18 inches inside measurement, the "Special," 10 inches × 11 inches × 20 inches. The box ends should be of ¾ inch stuff, the sides ⅜ inch to prevent bulging and the top and bottom of ¼ inch material.



Fig. 64. As a commercial proposition, trees of this type are seldom worth bothering with. For profitable renewal, the trees must be fairly healthy to start with

The sides should be of one piece and the bottom and top of two pieces each.

There is considerable discussion just now as to the place of the fancy box pack in middle west commercial apple growing. It is the belief of the writers that the barrel will not soon be superseded as the commercial package for a large proportion of the commercial output. At the same time for the fancy grades of fruit the box will come into use here because it is needed. The barrel is too large

a package for a city man to buy at one time. The smaller package, put up in fancy shape, with only carefully graded and uniformly colored apples, will claim its place as a container for choice Indiana fruit as well as for choice fruit from other localities. The great essential in box packing is grading to a uniform size. Special packing and grading tables are generally provided, as well as box nailing presses.

Figures 35 to 39 show the leading types of commercial box packs. The letters within the circles indicate the order of placing in position. The diagonal pack is used in commercial work far more than the straight and that known as the offset is comparatively rarely seen. The diagonal pack may be put up with either three and one half or four and one half tiers to the box. The following table explains the structure of the pack for various sizes of apples. The grading board is used to determine the size of the fruit and all apples that will not go through the three and one half inch hole are packed three and three and a half tier. The three inch and up to three and one-half inch sizes are four and one-half tier and smaller than two and three-fourths are five tier apples.

TABLE OF COMMERCIAL APPLE PACKS[1]

Box	Tier	Pack	Number apples in row	Number rows in width	Number layers in depth	Number apples in box
Standard	3	Straight 3	5-5	3	3	45
"	3½	Diagonal 2-2	4-4	3½	4	64
"	3½	Diagonal 2-2	4-5	3½	4	72
"	3½	Diagonal 2-2	5-5	3½	4	80
"	3½	Diagonal 2-2	5-6	3½	4	88
"	4½	Diagonal 3-2	6-6	4½	5	150
"	4½	Diagonal 3-2	6-7	4½	5	163
"	4½	Diagonal 3-2	7-7	4½	5	175

[1] "Better Fruit," September, 1910

V.—SPRAYING

It will be assumed in the following discussion that the necessity of spraying as a regular routine part of the fruit growers' program, is already conceded. There is no room for argument about this question among commercial fruit growers. It is also assumed that the orchardist has a general notion of the appearance and life history of the more common orchard pests. Life histories, descriptions, etc., are given in detail in some of the publications mentioned in the appendix and in other publications of this station. These should be studied and correlated with operations made in the field until the behavior and gross appearance of the more common insects and fungi is fairly familiar.

The following are some of the common typical insects and diseases which the commercial grower is likely to have to combat, and with which he should be on speaking terms—San Jose scale (Aspidiotus perniciosus), Scurfy scale (Chionaspis furfura), Codling moth (Carpocapsa pomenellâ), Plum curculio (Conotrachelus nenuphar), Black Rot (Sphaeropsis Malorum Pk.), Bitter Rot (Glomerella rufomaculans Berk.), Blotch (Phyllosticta solitaria E. and E.), Sooty Blotch and Fly Speck (Leptothyrium Pomi, Mont. & Fr.), Blight (Bacillus amylovorous, Burr.) and Scab (Venturia Pomi Fr.)

There are a number of insects other than those mentioned which are more or less common and which are liable to do considerable damage. These may include the apple curculio, the tent caterpillar, the spring canker worm, the bag worm, the leaf folder, the leaf skeletonizer, the leaf roller, the white marked tussock moth, etc. If codling moth and curculio are controlled, however, and the diseases mentioned held in subjection by proper spraying, most of the lesser enemies of the apple crop will be held below the danger line, in the process.

The commercial apple grower is interested primarily in spraying practice. He should however be familiar enough with the principal pests he is trying to control, to understand the principles underlying spraying and to know the reasons for his spraying operations. Spraying practice at the present time is undergoing a revolution. With the advent of the dilute lime-sulphur solution and its successful use as a summer spray in place of Bordeaux mixture and with the substitution of arsenate of lead for Paris green, great advances have been made. Changes and improvements are going on so rapidly that recommendations of five years ago are completely out of date. It is not unlikely that the spraying program outlined below will be modified more or less within the next few years, as formulas

are improved and as experiment and investigation throw additional light upon the problems involved.

Dormant Spraying.—Whether or not spraying when the trees are dormant is necessary depends entirely upon the condition and previous treatment of the orchard. If San Jose scale is present or if there is a considerable amount of scurfy scale, an application of lime-sulphur should be made before the buds swell in the spring. If the orchard has been neglected for a number of years, the application of lime-sulphur while the trees are still dormant is an excellent first step in the spraying treatment of the orchard for the season, even if it is not infested with scale. The lime-sulphur solution at winter strength acts not only as a scale killer, but also destroys the moss and lichens which may be on the trees; it is a powerful fungicide and may also kill the eggs of a number of insect pests. It is used in the neglected orchard to help in the general "cleaning up."

For winter use against scale the lime-sulphur solution should be used at a strength of about 1.03 to 1.04 specific gravity or about five degrees Baume. The greater strength of 1.04 specific gravity should be used for severe infestations of San Jose scale. This is approximately equivalent to diluting the usual commercial lime-sulphur with eight times its own volume of water. For explanation of dilution of lime-sulphur, see page 98.

Summer Spraying Material—Bordeaux vs. Dilute Lime-Sulphur.—The lime-sulphur solution has been the standard spray for San Jose scale for a number of years. It has also been known for a long time that the lime-sulphur solution possessed great fungicidal value. When used early in the spring on peaches it has been found to be practically a specific against the peach leaf curl, a fungous disease.

Within the past few years a large amount of work has been done in the effort to extend the usefulness of the lime-sulphur solution by working out formulas and dilutions which might make this spray available for summer use as a fungicide as well as for winter use as an insecticide. These efforts have been in large measure successful and at the present time lime-sulphur solutions in very much more dilute form than are used for the eradication of scale, are being used for the summer applications in place of Bordeaux mixture for the control of a number of fungous diseases.

Bordeaux mixture has heretofore been the standard fungicide. It has been well known to fruit growers, however, that Bordeaux was not an ideal spray. It sometimes causes severe burning of both fruit and foliage. On the fruit, the Bordeaux injury which often occurs consists typically of a russeting of the surface of the fruit.

This may be very slight or it may be so severe under certain not very well understood conditions as to make the fruit of the varieties most susceptible to the injury, deformed and practically unmarketable. In severe cases of Bordeaux injury the fruit has not only suffered in appearance but the yield has been seriously cut as well. Bordeaux injury or Bordeaux russeting is by no means universal, of course, or the spray would not have held its place as the leading fungicide for so many years. In some seasons very little Bordeaux injury is reported and many orchards escape entirely.



Fig. 65. This common type of poor top can be prevented by proper pruning while the tree is young. It can be corrected to a great degree by heading in from eight to 12 feet

The work with the dilute lime-sulphur preparations has indicated that the burning to be expected from them when properly made and applied is very much less serious than that from Bordeaux. In numerous cases, certain serious fungous diseases of the apple have been almost perfectly controlled and the fruit brought

to maturity with no appreciable injury. Not only has the fruit not been injured, but there has been a general opinion developed that the dilute lime-sulphur sprayed fruit has been fairer and smoother, with a finer finish and bloom than Bordeaux sprayed fruit ordinarily possesses, even when apparently not injured.

The dilute lime-sulphur has the additional advantage of being rather cheaper and easier to prepare than Bordeaux. In the early work it was predicted that the dilute lime-sulphur could not be successfully used with arsenate of lead on account of certain chemical reactions which take place when the two substances are united, and which were held to lessen the efficiency of both. In practice, however, it has been pretty conclusively shown by later experiments that the arsenate of lead does not lose its insecticidal value by being combined with dilute lime-sulphur, and some recent work points strongly to the conclusion that the fungicidal value of the mixture is increased rather than decreased by the addition of the arsenate of lead.

It is probable that we do not yet possess the ideal spray. Observations during the present season indicate that lime-sulphur and arsenate of lead even in dilute form may cause considerable injury, although it is possible that the extremely hot weather following some of the spraying may have been an important factor. As indicated above, spraying practice is changing ground rapidly at the present time. For this reason it is unsafe to predict the developments which the next few years may bring. At the present, however, the dilute lime-sulphur solution has proved its place as an important fungicide. It has several advantages over Bordeaux and in many sections has almost displaced it as a summer spray for the apple orchard. Certain fungous diseases have not been as yet so successfully controlled by it as by Bordeaux. This is the case with bitter rot and probably with apple blotch as well. Scab has been controlled as well with dilute lime-sulphur as with Bordeaux.

Bordeaux still has a place, and may retain it for some time to come. For the control of scab, fruit spot, leaf spot, and cedar rust, however, dilute lime-sulphur solution is recommended in place of Bordeaux. In orchards where it is necessary to spray for bitter rot, the dilute lime-sulphur may be used early in the season for scab, and then followed at the proper time with Bordeaux. In this way the russeting by Bordeaux, which usually follows the early applications, may be avoided, and the rot controlled.

Arsenate of lead may and should be used in connection with the dilute lime-sulphur to control codling moth and other insects. Two pounds of arsenate of lead to each 50 gallons of spray are usually sufficient. Two pounds and a half are often used and some-

times as high as three pounds. It is doubtful if the extra expense of the latter strength is justified or followed by any better results than the others mentioned. The extra amount of arsenate will probably do no harm but in commercial spraying the cost of the material is an important consideration.

Summer Spraying—Time of Application.—The following schedule is recommended:

1. Spray first just before the blossom clusters open. The leaves will be partially grown at this time. Use dilute lime-sulphur and arsenate of lead. The fungicide at this time is essential for the control of scab. The scab fungus often attacks the stem of the blossoms and forming fruit, and causes them to drop. The early application should not be omitted.

2. Spray just after the petals fall. Use the same materials. No orchard should be sprayed in full bloom. The second spraying may begin, however, before all the petals have fallen. The central blossom in the cluster is the one which is generally most likely to set fruit. It is apt to open and be fertilized several days earlier than some of the side blossoms of the cluster. A good rule to follow is to begin the second spraying when two thirds to three quarters of the petals are off. This is the most important spray for the codling moth and should be as thorough as it can possibly be made. Every calyx cup should receive a dose of poison.

There has been considerable controversy during recent years about the relative merits of the coarse, driving spray applied at very high pressure, and the mist spray. It has been shown pretty definitely that the essential thing is *thoroughness* of application, rather than character of spray. If a coarse driving spray be used at all, it should be used at this time, as the main object is to cover and fill and coat the calyx cups.

3. Spray the third time from two to three weeks after the petals fall.

4. Spray the fourth time about eight weeks after the petals fall.

If it is necessary to spray for bitter rot, Bordeaux should be used in place of dilute lime-sulphur, for the fourth spray, and the application should be made from the last week in June for the southern part of the state to the first week in August for the north. This Bordeaux spray for bitter rot should be repeated in about two weeks.

Strength of Spray to Use.—For summer use the lime-sulphur should be used at about 1.007 specific gravity or one degree Baume. This is roughly equivalent to a dilution of commercial concentrated lime-sulphur made by using one and one half gallons

to make 50 gallons of spray. The commercial concentrates vary in strength somewhat, however, so that dilution by measure alone is not very trustworthy.

The arsenate of lead should be added to the spray just before using. The required quantity for the amount of spray solution in



Fig. 66. These mature trees, whose tops were too full to be sprayed, economically, have been improved by a moderate heading in. Probably more would have been better

the tank should be weighed out and worked up with enough water before adding to the lime-sulphur solution to make it fluid, so that it will mix readily and thoroughly. This may be made up in stock solution and measured out for immediate use.

How to Make Bordeaux.—Bordeaux mixture is composed of copper sulphate (blue stone, blue vitriol) lime, and water. The copper sulphate is the active fungicidal agent and the lime is added to prevent burning. When the two materials are mixed a number of complex chemical changes occur which unite the lime and the copper sulphate in various ways, so that free copper sulphate solution is not present in a properly made mixture.

The essential thing in the making of a first class Bordeaux is to mix the lime water and the solution of copper sulphate in as dilute form as possible. The object of this is to obtain a mixture which will remain in suspension well. If a concentrated or "strong" solution of copper sulphate is mixed with thick lime water, the mixture "curdles." A coarse heavy precipitate is formed which settles very rapidly. Such a mixture may contain the same quantities of lime and copper sulphate as a properly made mixture, but it is almost worthless for spraying purposes. It settles to the bottom of the tank in spite of agitation; it is liable to clog the nozzles; it makes the solution of varying strength, since the heavier portion near the bottom will be sprayed out first leaving a thin, watery mixture with not enough lime and copper sulphate in it to be any good, to be sprayed out last. On the other hand if the lime water and the solution of copper sulphate are diluted separately, and then mixed, a light, flocculent precipitate is formed, which settles very slowly and which makes a desirable spray.

Formulas for making Bordeaux vary considerably. The one recommended is eight pounds of copper sulphate, 10 to 12 pounds of lime, to 100 gallons of water. Freshly burned stone lime should be used. That which has been partially air slaked is not satisfactory. Process or hydrated lime may be used if desired. It may sometimes be obtained much more easily than fresh stone lime. Hydrated lime is ground to a very fine powder and needs only to have water added to it to make it ready for use. The water should be added slowly until the mixture is thin. Of process lime the larger amount (12 pounds) should be used.

On no account should a greater quantity of copper sulphate be used than lime.

A number of different plans have been worked out in practice for the convenient and economical preparation of Bordeaux mixture in large quantities. Often a stream or pond is utilized as a water supply. Sometimes a pond is dug in the orchard. Some orchardists depend on a well in the orchard. The usual plan is to provide two tanks (sometimes two or more 50 gallon barrels are used in place of large tanks) for a stock solution of lime and copper sulphate, with dilution tanks which may be easily filled and

from which the two ingredients (dilute lime water and dilute copper sulphate solution) may be run together and mixed in fully diluted form in the spray tank. One hundred pounds or more of copper sulphate may be dissolved in water by being suspended in a sack or coarse splint basket near the surface of the water. The water will eventually dissolve about two pounds per gallon. It is usually more convenient to make up the stock solution by dissolving the copper sulphate at the rate of a pound per gallon. Thus a 100 gallon tank would contain 100 pounds copper sulphate dissolved, or a 52 gallon barrel would hold 50 pounds dissolved in 50 gallons. The lime water may be made up in similar fashion. These are the "stock" or concentrated solutions. If it is desired to make 100 gallons of Bordeaux, eight gallons (containing in solution eight pounds) of the stock solution may be measured out and run into a dilution tank and mixed with enough more water to make 50 gallons. Similarly, 10 gallons of the lime water may be measured out (after stirring well to obtain a uniform mixture) and diluted. These two dilute solutions may now be run into a third tank to mix or they may be run directly into the spray tank, mixing as they flow in. Another common and convenient method is to fill a third tank (the spray tank itself may be used) with half the total quantity of water desired, or 50 gallons if 100 gallons of spray are to be made. The stock solutions then need to be diluted each to one quarter the total volume or 25 gallons. They may then be run through separate channels into the spray tank or other tank holding the balance of the water required. The elevated platform for mixing may be dispensed with entirely and all the work done on the ground, if a gasoline engine power sprayer is used having an accessory pump for filling.

Any spray material containing lime should be strained before being put into the spray tank. A very excellent form of strainer is that shown in Figure 46, which was designed by Professor Stewart, of Pennsylvania State College. The advantage of this strainer over the old types is that the sediment collects *below* the screen instead of on it.

Dilute Lime-Sulphur.—The lime-sulphur solution for use in apple spraying may either be bought ready made or prepared at home. The tendency now seems to be toward the use of the commercial product. As the spray becomes better known and as the methods for making it are perfected and more widely understood, it is probable that a great many commercial orchardists will manufacture it for themselves.

As indicated above, the better commercial brands test about 32 or 33 degrees Baume. At this strength they contain about two

and one half to two and three fourths pounds of sulphur per gallon and may be diluted for summer use in the apple orchard at the rate of one and one half gallons per 50 gallons of water.

The material may be prepared at home by boiling lime and sulphur together in the following proportions for one hour: 36 pounds of lime (based on pure lime, Ca O), 80 pounds of high grade finely divided sulphur and 50 gallons of water. When lime containing 95 per cent. or less than 95 per cent. of calcium oxide is



Fig. 67. These low, compact tops have been developed by heading in of what were formerly "sky scrapers." These trees can be cared for; before they could not

used, more than 36 pounds must be taken, according to amount of impurities (38 pounds for 95 per cent. lime and 40 pounds for 90 per cent. lime) but no lime should be used containing less than 90 per cent. of calcium oxide or more than five per cent. of magnesium oxide. In boiling the solution, the liquid must not be allowed to drop more than slightly below the 50 gallon level.

Method for approximate determination of impurities in lime: —"This test is based upon the fact that when one part of pure lime and two parts of sulphur are boiled with plenty of water for one hour, only slight amounts of sediment appear. If the lime contains impurities, these appear as sediment, the amount of the sediment being an approximate measure of the amount of the impurities."

The above formula is recommended because extensive experiments have indicated that the proportions of lime and sulphur given, together with the required boiling produce a solution of lime and sulphur having the greatest amount of sulphur in solution in the most valuable insecticidal form, the least sediment and the greatest permanency. It is not at all difficult to make a lime-sulphur solution by this formula with a strength of 26 degrees Baume, which compares not unfavorably with the commercial preparations. This is a concentrated material and must be greatly diluted for either winter or summer use. If put into tight casks which are filled as full as possible and bunged tightly, it will keep as well as the commercial concentrate. It may be made any time during the late winter or early spring and used at once for San Jose scale or set aside for summer use later. For a week or more the home-made concentrate may be kept in open barrels if a layer of coal oil or crude oil be poured over the top of the mixture to protect it from the air.

It should be noted that limes having a high magnesium content are not suitable for the making of lime-sulphur spray. The analysis of a number of typical Indiana limes will be found in the appendix.

The cost of making at home a 26 degree Baume lime-sulphur was carefully estimated the past spring from a quantity the Station made for use in a demonstration orchard in Greene county, and the expense was as follows:

450 pounds of sulphur @ $.03 (including transportation	$13.50
225 pounds of lime @ $.01	2.25
Two men two days @ $1.50	6.00
	$21.75

The above made six barrels of material, costing $3.63 per 50 gallon barrel. This is exclusive of kettles, barrels and fuel. First class barrels will cost about $1 each.

The commercial lime-sulphur solution sells at from $7 to $9 per barrel. If the home-made lime-sulphur be prepared on a large scale, to compare with car-lot prices on the commercial product, the cost per barrel would undoubtedly be below $3.50 at present prices of lime and sulphur. The commercial product usually con-

tains more sulphur in solution than the home-made and can therefore be diluted somewhat more. This difference however, does not offset the difference in cost.

The decision as to whether the lime-sulphur solution shall be made at home or bought ready made, will rest with the individual and will be based upon his own opinion as to whether in his individual case, the convenience of not having to make the material is or is not worth the three to five dollars difference in cost per barrel of concentrate.

THE HYDROMETER AND ITS USE.—The hydrometer is an instrument designed for use in determining the densities of solutions. It



Fig. 68. Healthy specimens of worthless varieties may be made profitable by top grafting. Two scions are usually inserted in each cleft stub. The scions should be so cut as to have an outside bud at the point indicated. All exposed surfaces are protected with a coat of grafting wax

consists of a long glass neck or stem upon which is marked a graduated scale, a cylindrical glass air chamber larger than the neck, and a weighted spherical base containing shot or quick silver. If the hydrometer is placed in pure water at a temperature of four degrees Centigrade (equal to 40 degrees Fahrenheit) it will sink until the

reading on the specific gravity scale is 1. If something be dissolved in the water, such as sugar or salt or compounds of lime and sulphur, the liquid becomes denser or heavier so that the hydrometer will not sink so far into it. The stem will project further from the water and another figure will appear at the surface of the liquid. The reading then at the surface indicates the *specific gravity* of the solution, or its density in relation to the density of pure water at four degrees C. which has been arbitrarily taken by physicists as one. The more material the liquid contains in solution, the greater will be its density and the higher the specific gravity reading.

The Baume scale is another arbitrary scale which is largely used by manufacturing chemists. The hydrometer reading in degrees Baume indicates the same thing as the reading on the specific gravity scale only in different terms, that is, it also indicates the density of the solution. The following conversion table indicates the relation between the two scales. The relation indicated is exact for sulphuric acid at a temperature of 60 degrees F. and corresponds closely enough to lime-sulphur readings:

TABLE FOR CONVERSION OF BAUME READINGS INTO EQUIVALENT SPECIFIC GRAVITY READINGS

Baume	Specific Gravity	Baume	Specific Gravity
1	1.007	21	1.169
2	1.014	22	1.179
3	1.021	23	1.188
4	1.028	24	1.198
5	1.035	25	1.208
6	1.043	26	1.218
7	1.051	27	1.229
8	1.058	28	1.239
9	1.066	29	1.250
10	1.074	30	1.261
11	1.082	31	1.272
12	1.096	32	1.283
13	1.098	33	1.295
14	1.107	34	1.306
15	1.115	35	1.318
16	1.124	36	1.330
17	1.133	37	1.342
18	1.142	38	1.355
19	1.151	39	1.368
20	1.160	40	1.381

Hydrometers are now on the market which are designed especially for use in figuring dilutions of lime-sulphur solutions. They have both the specific gravity and Baume scales, and are graduated from one degree to 35 degrees Baume with the corresponding specific gravity readings from 1.007 to 1.318.

The manufacturers of commercial lime-sulphur solution usually guarantee their product to test a certain number of degrees Baume. If the solution contains, as it should contain, nothing but lime-sulphur in solution, the hydrometer reading is a trustworthy indication of its value. It has been found that the commercial preparations vary somewhat in strength so that simply for self-protection the buyer should use the hydrometer in order to know whether he is getting what he is paying for. The hydrometer is possibly even more useful in figuring the proper dilutions, since by its use it is possible to reduce any concentrated solution of lime-sulphur to a definite and constant spraying strength regardless of variations in the strength or density of the concentrate. This makes it essential that the hydrometer and its use be understood if the concentrated lime-sulphur solution be made at home.

It has been found that a lime-sulphur solution in order to be effective in eradicating the San Jose scale should have a specific gravity of from 1.03 to 1.04. The greater strength of 1.04 is recommended for severe infestations while 1.03 is usually sufficient for mild cases. It will be noted by referring to the table that a Baume reading of five degrees is equivalent to 1.035 specific gravity. For summer use as a fungicide for apple disease, in place of Bordeaux, the lime-sulphur solution must be much more dilute and here it has been found that a density of one degree Baume or 1.007 specific gravity is dilute enough to be fairly safe and strong enough to be efficient. The following formula has been worked out for accurate dilution, by Prof. J. P. Stewart, of Pennsylvania State College.

$$\frac{\text{Decimal of concentrate}}{\text{Decimal of spray desired}} = \text{number of dilutions}$$

For example suppose that the specific gravity of the concentrate is 1.283, (equivalent to 32 degrees Baume) and the spray desired is that having a specific gravity of 1.04 (for San Jose scale). Disregarding the figure before the decimal point, we have .283 divided by .04 = 7+ or the number of dilutions which this particular concentrate should receive to make it of the desired spraying strength.

To dilute seven times add six volumes of water.

The following table will be found useful in making dilutions from concentrates of various strength:

[1]Dilutions for Dormant and Summer Spraying with Lime-Sulphur Mixtures

Reading on hydrometer	Amount of dilution Number of gallons of water to one gallon of lime-sulphur solution	
	For San Jose scale	For summer spraying of apples
Degrees Baume		
35	9	45
34	8¾	43¼
33	8¼	41½
32	8	40
31	7½	37¾
30	7¼	36¼
29	6¾	34¼
28	6½	32¾
27	6	31
26	5¾	29½
25	5¼	27¾
24	5	26
23	4½	24¼
22	4¼	22¾
21	3¾	21¼
20	3½	19¾
19	3¼	18¼
18	3	17
17	2¾	16
16	2½	15
15	2¼	14
14	2	12¾

Hydrometers especially designed for lime-sulphur are manufactured by the Bausch & Lomb Optical Co., Rochester, N. Y. The hydrometer, including a tall glass cylinder to use it in, costs $1. The outfit may be ordered direct or through local druggists.

Spraying Outfits.—The two great factors in the successful spraying of the commercial orchard are thoroughness of application

[1] Adapted from New York Agricultural Experiment Station. Bulletin No. 330

and economy and speed of operation. It is impossible to spray thoroughly, rapidly or economically without an adequate spraying outfit. To be adequate to the needs of the commercial apple grower the spraying outfit needs to be complete in all its parts. The question of water supply must be thought out and solved in the most labor saving and efficient direction. Repairs that are likely to be needed should be provided and on hand before the spraying season opens. It is poor business management that stops a power outfit and loses a day's time or more while a new hose is being secured or nozzle repaired. Extra lengths of hose, extra extension rods, extra nozzles, hose clamps, etc., should be bought before spring opens. The spraying program should be carefully thought out and arrangements made so that spray materials will be on hand. If concentrated lime-sulphur is used, it is especially necessary that the ordering be done early. Arsenate of lead should also be on hand in sufficient quantity for the season's requirements.

The quantity of material to buy is always a puzzling one for the inexperienced grower. There are so many variable factors too, which may affect the quantity of spray used that it is difficult to give an estimate. The pressure at which the spraying is done, the size opening in the nozzle caps, the velocity of the wind, the condition of the trees in regard to amount of wood in the top, all have an important bearing. The trees shown in Figure 24 are 32 feet apart each way. They are mature and beginning to crowd. They have been pruned regularly and the tops are not over full of wood. In the second spraying, (just after the petals fell) these trees received a heavy drenching with Friend nozzles at about 150 pounds pressure. There was a moderate breeze part of the time and the trees took on the average nearly 10 gallons each. In the next spraying the application was lighter, the purpose being simply to coat all the leaves and setting fruit, rather than to fill the calyx cups. This spraying required only about four gallons per tree. The type of spray outfit to purchase depends upon the size and character of the orchard. For a small commercial orchard a barrel pump may be sufficient for the first few years. An excellent type is shown in Figure 50. It doesn't pay to use the smaller types of barrel pump. Only the largest and most powerful pump made for use in a 50 gallon barrel should be considered. In general it may be said that the spraying outfit should be large enough to go over the entire orchard in six days of work. This means that the orchard size limit for the barrel pump or even for several barrel pumps is soon passed. In fact, many orchardists claim the barrel pump has no place in the commercial orchard. A more powerful type of pump is shown in Figure 52 and consists of a heavy double acting pump mounted hor-

izontally, and operated by a long upright handle. Greater power can be developed by this type and with less labor than is possible with the barrel pump. The horizontal pump may be mounted for use with a barrel or, preferably, for use with a half round tank mounted on trucks.

For the larger orchards the power sprayers are most economical. Ten acres of mature orchard are often placed as the maximum to be handled by hand pumps. Any thing over this size is more than likely to justify the use of a power sprayer. Of the several types of



Fig. 69. Cleft grafting an unprofitable variety. The wedge of the grafting chisel is used to hold the split stub open while the scions are inserted

power sprayers used, the gasoline engine type is the most popular. The prices for gasoline sprayers complete with trucks, tower, tank, etc., vary from $225 to $450. Those intending to purchase should communicate with the firms mentioned in the appendix and should study their catalogues and compare the various outfits with their own judgment of their own requirements and be guided accordingly.

VI.—RENEWAL OF OLD ORCHARDS

The position which Indiana is to take in the future among apple growing states depends to a great degree upon the orchards which are now being set. This position, however, may be greatly affected by the action which will be taken within the next five years in regard to the renewal of the old orchards which have been neglected. The new orchards must be properly cared for from the start, and such of the old orchards as still preserve some measure of health and vitality in spite of their past ill-treatment, must be renewed, and reclaimed if Indiana takes the place she should take as an apple producing state and if the fruit growers of Indiana live up to their opportunities.

The general economic reasons for the decline of many orchards which were once vigorous and healthful and producers of regular crops of fine apples, are sketched in the first few pages of this circular. It is the purpose here to give some suggestions in regard to the best means of overcoming the effects of years of neglect, and of putting such of these old orchards as may be susceptible to treatment, back on a paying basis and in such condition that they may again gladden their owners' hearts, and gratify their palates with the remembered apples of their youth.

In order to make this discussion coherent in itself, some factors of location and management are noted briefly, which have been discussed more fully in other sections of this circular.

Present Conditions.—The present condition of many of the old home orchards of the state is deplorable. Many that were set out for commercial purposes are also in a state of decline. Often the selection of varieties is poor. In many cases purchases were made according to the judgment of the traveling tree peddler and the mistake made of setting a few trees each of a large number of varieties. When the trees came into bearing it was too often found that more or less substitution had been made and many of the varieties proved quite different from those ordered. In nearly all of the earlier orchards and in many recently set ones, the trees were put too close together. They have seldom been pruned. The trees look very much like elevated brush heaps upon which hang a few specimens of gnarly, wormy fruit. The orchard soil has never been cultivated. It is overgrown with orchard grass or weeds and is usually used as a hog or calf pasture. The trees are on the verge of starvation as they have never been fertilized. The majority of these orchards have been sprayed at some time in their existence but as no results were accomplished, due to inadequate outfits and

to poor application, this has long since been discontinued. Now the trees are a breeding place for all the pernicious insects and fungous diseases to which the apple tree is subject.

Is the Orchard Worth Renewing.—With the recent revival of horticultural interest comes the desire for information on the subject of orchard renewal. It has been demonstrated time and again that under proper management an old, neglected, run-down orchard can again be made to yield profitable crops. The first question which confronts the owner of an old orchard is—"Is my orchard worth renewing?" All orchards cannot be profitably rejuvenated. Some old orchards had better be cut down and new ones planted rather than to spend time and money in the effort to renew them, as the rejuvenation operations would fail and would discourage any further effort to progress. In deciding whether or not to renew an orchard, the first thing to ascertain is the number of healthy trees in the orchard plot. At least 50 per cent. of the trees should be fairly healthy and from 10 to 20 per cent. more capable of being saved by judicious treatment. The health of the trees is the leading consideration. When the condition of the trees has been determined the next thing to consider is the varieties. When renewing an orchard for home purposes, the varieties are of less importance, but when the renewal is for commercial purposes the varieties present and the number of each variety should be closely ascertained. The varieties should be of standard sorts and such as are demanded by the trade. There should be enough of each variety so that it will pay to market them. The number of varieties which can be handled profitably in a commercial orchard is small and depends upon the market catered to. If the orchard is to be used to supply the local trade a relatively large number of varieties are permissible and should include both early and late sorts. If the orchard is large and is to supply the wholesale trade, the fewer varieties present the better. (For a fuller discussion of this subject, see page 37.

The location of the orchard should also be considered before it is taken for renewal. It should be close to the market or should have good transportation facilities. It should also be located near some region of plentiful labor as many good crops are poorly handled through lack of pickers, packers and spray hands. The location should also be considered from the standpoint of site and exposure. It is just as important to have the orchard to be renewed, as it is to have the young orchard, on a satisfactory site.

If the orchard has an improper site and exposure no amount of care can make it produce profitable crops each year. In choosing an orchard for rejuvenation, all of the precautions mentioned in the

pages on "choosing a site for the young orchard," should be carefully studied as such factors as poor air-drainage, and wrong exposure cannot be overcome in a mature orchard.

If an orchard has a fair percentage of the trees healthy, a good selection of varieties and a good location, it can be profitably rejuvenated.

Specific Factors of Orchard Decline.—Before any condition can be remedied the causes which bring about the condition must be fully understood. The reason for the deplorable condition of many old Indiana orchards can be summed up in the two words —*ignorance* and *neglect*. There are various phases of ignorance and neglect which tend to bring about the decline of an orchard. The trees are generally planted too close together. The average distance between bearing trees in this state is about 25 feet. This is entirely too close for standard sorts and the branches not only interfere, but the roots crowd and compete with each other also. Two trees cannot occupy the same feeding area and both make a satisfactory growth. The closeness of the trees also prevents good air drainage. Whenever the air drainage is poor the crop is apt to suffer from frosts. Frost will settle in places of little or no air circulation on nights when no frost occurs on areas where the atmosphere is in constant motion. This fact can be held responsible for the poor setting of fruit in many of our older orchards. Wherever poor air circulation is found the atmosphere is generally moisture laden.

This increased moisture content of the atmosphere is conducive to fungous growth which partially accounts for the omnipresent "rotten apple" in the neglected orchard.

The soil upon which orchards have been planted in the past was often the poorest on the farm. This condition was brought about through the mistaken idea that because an apple tree would *grow* on poor soil that it *needed* poor soil. The trees on this poor land made good growth until they reached bearing age and placed an extra tax on the soil. With this increased drain, the available plant food generally gave out and the fruit production gradually decreased to a few unsalable bushels of fruit per tree. The wood growth was also lessened until the trees, instead of making the normal eight to 12 inches of growth, only made from one to three inches of wood per season. Often the soil of these old orchards has never been replenished by fertilizers or cover-crops or even by means of cultivation. An apple crop cannot be grown without food any more than can a crop of hogs. The lack of food for the trees is one of the important causes in the decline of the bearing orchard of today.

Even the poorer orchard soils generally contain sufficient plant food if it could all be used by the trees. This food is, however, locked up in an unavailable form and only becomes available very slowly unless helped by artificial means. Cultivation is one of the best means of rendering plant food available. Very few bearing orchards are cultivated or ever have been cultivated. They are choked with grass, weeds or brambles which are robbing the trees of the plant food just as soon as it becomes available as well as appropriating the soil moisture. Most orchards which can be cultivated without danger from washing should be broken up at once. Only one crop should be allowed to grow on the orchard site and that should be the fruit crop.

Another influential factor in the decline of bearing orchards is the lack of pruning. Pruning has caused more worry to orchardists than any other factor mentioned and yet is far from the most important one. Every man who owns an orchard has at one time or other decided that the place "needs pruning." The result is a wholesale pruning all at one time and then a forest of water sprouts the following season. This vigorous pruning throws the trees into wood production at the expense of fruit production and the owner becomes disgusted with pruning and decides that it is an unnatural process and one not to be indulged in. He has forced a head full of water sprouts onto his trees and these are never removed. Crops are sometimes borne by trees which have never been pruned, but these are not satisfactory crops. An apple tree whose head is choked up with useless branches and water sprouts cannot be expected to produce a crop of first class fruit even if it is fed and sprayed. In order to get the best out of a tree it should have a low, wide-spreading, open head so that the sunlight can reach every fruit and the breezes have unobstructed passage through the branches. The ordinary thick topped, unpruned tree cannot produce crops of salable fruit unless it is pruned and until the first pruning is followed up yearly with light prunings consisting of the removal of water sprouts and unnecessary branches.

The most important factor in causing the downfall of our bearing orchards is the lack of spraying. Neglect of spraying has ruined more orchards than all of the other factors mentioned combined. When this reason is given as the most important cause instrumental in the undermining of the present day apple industry numerous orchardists of the old school immediately say that spraying has nothing to do with the lack of production. They call in the forces of nature and say, "The climate has changed." A close scrutiny of the official weather records will show that no such change has taken place. The lack of production cannot be blamed

upon the weather. It is due to the neglect of the owner of the orchard. The most important phase of this neglect is the lack of spraying. It is granted that a generation or two ago fruit could be grown without spraying, but that was before the advent of the San Jose scale, the codling moth and the numerous plant diseases.

The man who raises high quality fruit today must spray, and spray four or five times throughout the season. Rotten and wormy fruit has no place on the market and if an old orchard is worth the ground it stands upon, it is worth spraying.

How to Go About Orchard Renewal.—After becoming thoroughly acquainted with the causes which bring about the decline of the orchard, the next thing to consider is just how to remove these causes. When taking an old orchard for renewal, it is often times difficult to know just where to begin. There are often so many causes contributing to the decline that it is a question which one to remedy first.

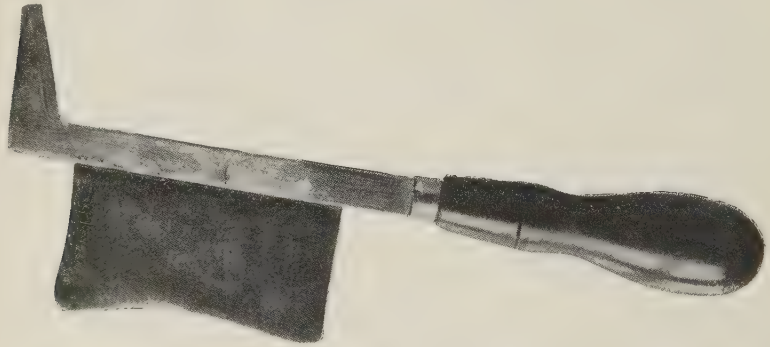


Fig. 70. A common type of grafting tool. Often the end is provided with a hook instead of a handle

The best time of year in which to examine an orchard preparatory to renewal is in the fall. The majority of the trees have borne some kind of a crop and at this time a majority of the varieties can be identified, and should receive attention before any rejuvenating work is done. The next step necessary in the renewal of the orchard is a working plan of the place. All of the trees should be located on paper and their variety indicated, their distance apart mentioned and all vacancies shown. With this plan a large amount of work can be done at odd times in the winter. This work is preparatory to the actual work of rejuvenation and should be conscientiously done if the later work is to be accomplished in the most economical manner.

Mature apple trees on good soil should not be much less than 40 feet apart. The first real work in renewal then will be to so thin the trees that they will stand as near 40 feet apart as possible. In every orchard there are always a few trees that have never borne a satisfactory crop and never will. A few crabs and worthless varieties also creep into every orchard through ignorance and mistakes in ordering the stock. Dead and dying trees are present in nearly every old orchard. All of these non-producers should be located on the orchard map and then a system devised for so thinning the trees that a majority of the worthless individuals will be removed leaving the remaining trees standing as nearly as possible the required distance apart. The ease with which this can be done will, of course, depend upon the location of the worthless sorts and upon the original plan of planting. As most orchards are planted on the square plan this is relatively a simple matter since either every other row can be removed leaving the trees in rectangles the original distance apart one way and twice the original distance apart the other way, or every alternate tree in every row can be removed, which leaves the orchard according to the quincunx plan, or every other row can be removed and then every other tree in the rows which are left. This still leaves the trees in squares, but the squares are twice as large as originally planted. The method adopted will depend largely upon the distance apart and the age of the trees. It should always be remembered that a crop cannot be expected from an orchard where two trees are trying to occupy the same feeding area.

Just as soon as the system of thinning has been devised and the trees which are to be removed have been located on the map, the plan is taken to the orchard and all trees marked for destruction are blazed with a hatchet and the men are turned in with axes and mattocks to cut and grub them out. If this plan of thinning is followed out, the owner not only knows just what he had when he started renewing, but he also knows just what he removed and just what he has left. In other words he has a complete map of his orchard with every variety located on it; a convenience which very few practical orchardists appreciate.

The thinning process has occupied the early part of the winter and just as soon as this is finished the men can be started pruning the remaining trees. Great care must be exercised in this operation as the majority of men are imbued with the idea that a tree should be "trimmed up." The result is that all of the branches which are within reach of the ground are sawed off first and then the head of the tree is thinned out. The old apple tree should be kept just as low-headed as possible. The little inconvenience which is experi-

enced when cultivating the orchard is more than overcome by the greater ease with which the other orchard operations can be accomplished.

The old neglected tree is usually a forest of water sprouts and tangled branches. The first impulse is to remove all superfluous branches at once and get the tree in first class condition all in one season.

This is a mistaken idea. It has been demonstrated that heavy top-pruning tends to induce heavy wood growth which in a heavily pruned tree will largely take the form of water sprouts. These sprouts are absolutely worthless and should be removed as soon as possible.

The only place that a water sprout may function is in the replacing of a broken part. By proper heading in, a water sprout may be made to fruit within 10 or 12 years. Thus to avoid this overproduction of wood growth, the pruning operation in the neglected orchard should be extended over a period of at least three years.

The proper time to do this pruning is in the later winter months. Wounds made at this time heal much better than those made either earlier or later in the season. The first season's work should be limited to the removal of the dead and dying branches and the largest of the water sprouts. This, in the majority of old orchards, will be all that the trees can stand in one season without stimulating wood growth too much. The second season the remainder of the water sprouts and the crossing and interfering branches are removed. The third season the shaping of the head is started. In forming a head on a mature apple tree very little advice can be given. Each tree is a law unto itself and must be treated accordingly.

The tree should have an open head. Thin the branches out so that the sunlight can have free access. Without sunlight a poorly colored fruit will result. The head should also be open so that the air can circulate through the branches. The circulation prevents the air in the center of the tree from becoming moisture laden and is a great help in fungus control. No branches should be allowed to so cross that they will rub or interlock. Whenever two branches rub together an abrasion occurs and an entrance for fungous diseases is provided. After the third season the pruning will consist of removing the water sprouts, interfering branches and in keeping the head open. The pruning operation should be continued each year, as the sooner the undesirable branches are removed, the less food material there is wasted and the smaller the wounds are which have to be healed.

The pruning should be started early enough in the winter so that the brush can be hauled away and burned before the time to break the orchard sod has arrived.

Just as early in the spring as possible the orchard should be plowed. This can be done with the ordinary breaking plow, but it should be so set as not to turn a furrow of more than eight or 10 inches deep between the rows gradually getting shallower as the trees are approached on either side. Every inch of the sod should be turned if possible. By means of careful driving and often times the use of a small one-horse plow the sod can be turned right up to the trees. After the orchard has been plowed it should be thoroughly disked and harrowed. When the soil is in as good condition as that of the nearby corn field at planting time, harrowing can be discontinued but not before. As one of the main objects of cultivation is the conservation of moisture, the upper layers of soil should be kept in a very loose condition. This dusty surface forms a blanket over the soil through which the moisture cannot escape. In order to maintain this dust blanket the soil should be stirred every week or 10 days and after every rain. The best tool with which to do this is the ordinary spring-tooth harrow. It is heavy enough to thoroughly stir the ground and at the same time to pulverize the surface layer. This constant cultivation also has a tendency to liberate unavailable plant food. An old sod-bound orchard will oftentimes double its annual wood production the first season after cultivation.

The orchard is to be cultivated faithfully until the middle of July when a cover crop should be put in. (For discussion of cover-crops see page 73)

If the old orchard is so located that the soil cannot be broken up without danger of washing, it should be left in sod but should not be pastured nor should the hay be removed. The grass should be cut and allowed to lie where it falls. This is done two or sometimes three times throughout the season. The dead grass acts as a mulch to the surface soil which tends to check the evaporation of the soil moisture. The addition of straw, stable manure, or other organic litter is often added to the cut grass which increases the efficiency of the mulch and may add some plant food.

Fertilizing.—It has been noticed that one of the main reasons for lack of fruitfulness in old orchards is the impoverished condition of the soil. Cultivating has a tendency to remedy this condition by the liberation of heretofore unavailable plant foods. Cover-crops also help to increase the food content of the soil. These two factors alone, however, are not always of themselves sufficient for

the reclaiming of the worn out orchard soil. It is often profitable and even necessary to add some form of fertilizer.

One of the best fertilizers known for orchard crops is barnyard manure. An annual application of 10 tons per acre is often profitable.

The majority of orchardists, however, cannot obtain this amount of barnyard manure and they are forced to rely upon the different forms of commercial fertilizers. [1]"No recommendation will fit all cases, but present results indicate the desirability of the following combination (in amounts per acre):

30 pounds actual nitrogen (N)
60-75 pounds actual phosphoric acid (P_2O_5)
50 pounds actual potash (K_2O)

Such amounts of plant food are obtainable by mixing any one of the following combinations, the mixing being done either at home or at the factory:

(a) 100 pounds nitrate of soda (15½% N)
100 pounds dried blood (12½% N)
250-300 pounds steamed bone meal (24% P_2O_5 and 1% N)
100 pounds sulphate of potash (50% K_2O)

or (b) 100 pounds nitrate of soda (15½% N)
120 pounds dried blood (12½% N)
400-500 pounds acid phosphate (15% P_2O_5)
100 pounds sulphate of potash (50% K_2O)

or (c) 500 pounds of a 6-12-10 fertilizer"

Any of the above fertilizers should be scattered broadcast over the entire orchard area excepting near the trunks of the trees. This application is usually made just before the first cultivation so that it may be thoroughly harrowed in. As the seasons pass and the leguminous crops have been used year after year, the nitrogenous content of these combinations can be lessened. By means of the leguminous cover-crop nitrogen is taken from the air at a very nominal expense. Whenever possible the use of leguminous cover-crops, commercial fertilizers and barn-yard manure should be combined. Use the cover-crop each year and apply the commercial fertilizer annually, alternating every third or fourth year with stable manure at the rate of about 10 tons per acre to get the best results. The leguminous cover crop furnishes the necessary nitrogen, and some organic material; the commercial fertilizer supplies some nitrogen, the requisite amount of potash and phosphoric acid; and

[1] Pennsylvania State College Agricultural Experiment Station. Bulletin No. 100

the barnyard manure supplies all of the fertilizing elements as well as a large quantity of decaying organic material.

If the old orchard is ever to be brought back to its former state of fruitfulness, the trees must be fed. No intelligent farmer expects his corn or wheat to produce bumper yields year after year, on the same soil, without ample feeding, yet the same farmer often expects such results from his orchard. If the orchard is to be thoroughly renewed, it should be thoroughly fed.

SPRAYING.—Just as soon as the pruning has been finished and the brush burned, the first spraying should be done. This will generally be about the middle of March. The object of this application is that of sanitation. Most old neglected orchards are infested with about all the diseases and insect pests known to modern horticulture.

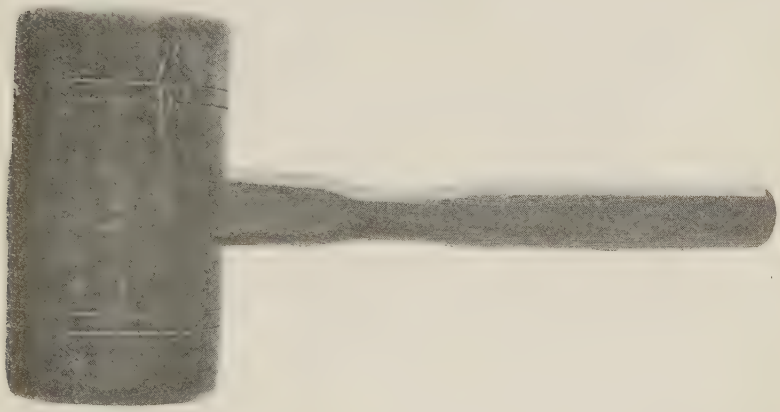


Fig. 71. Wooden mallet used in driving the chisel into the end of a stub, to provide a place for the scions. Do not split the stub any further than necessary

This late winter spray is applied to remove these sources of later infection. It is made with lime-sulphur at winter strength. (See page 87)

This concentrated solution may be applied only when the trees are in a dormant state, as lime-sulphur at this strength is so caustic as to badly injure either leaf or flower growth. The later spraying program should be that outlined on page 90.

Spraying in an old orchard should be done more carefully, if possible, than in the young orchard as the old trees have been neglected and a host of plant pests have already obtained a foothold. These first four sprayings have a double function, to kill the diseases

present and to prevent new infection. Every inch of the trees should be coated with spray material at each application as in the old orchard we are trying to cure as well as prevent.

Such a thorough job as this cannot be done except with the best of tools. When buying a spray outfit, it should be remembered that only the best should be purchased as the spray outfit is the father of the fancy apple.

Top Working.—In rejuvenating an orchard, the question of repair is always encountered. It often seems, when thinning trees in an orchard, that it is always the most vigorous and healthy specimens which occupy the spaces to be vacated and that the trees which are left generally have something the matter with them.

If too many of the trees left need repair, the work of thinning had better go right on until the entire orchard is removed. Too much repair has no place in the renewal of a commercial orchard while a few trees can often be repaired with profit, thus saving time in growing fillers.

Very often a perfectly healthy specimen of an absolutely worthless variety is left standing in an orchard after the thinning is finished. The tree, as it stands is useless. Science, however, has provided a way in which this individual can be forced to join the rank of the producers. This is done by cleft grafting into this tree scions of some standard sort.

The best time of year to do this work is in the late winter, just before the buds start to swell. The work is done by sawing one third of the larger branches of the head to stubs about two and one half inches in diameter. These stubs are then split with a grafting chisel (Figure 70) and the scions inserted. Scions are short pieces of last season's growth from some standard variety. They are cut wedge-like on the lower end and are about four buds in length. The wedge shaped end is inserted in the cleft in the stub. (Figures 68 and 69) Great care should be exercised in getting the cambium layer or sap wood of the scion to coincide in at least one place with the sap wood of the stock. Two scions are usually placed to a stub. When the scions are in place they are held in position and protected by a wax composed of four parts resin, two parts of beeswax and one part of tallow. These materials are melted to a homogenous mass and then poured into a pail of water in order to cool them. When the mass is cool enough to handle, it is pulled, like molasses taffy, until it takes on a smooth texture and a gray color. This wax is then worked around all cut surfaces of the stub and scions. Grafting wax can be kept indefinitely and is also used in propagating work, bridge-grafting and sometimes as a protection for wounds made in pruning.

Both scions generally grow and a shoot arises from each bud. If all of these shoots were allowed to grow, too great a drain would be placed on the union of stock and scion, so that all shoots are removed but the strongest one nearest the stub. This shoot is pinched back and all the other shoots, as well as the extra scion, removed. Care should be exercised throughout the following season to rub off all water sprouts from around the stub as these tend to weaken the scion.

Only one third of the top is worked the first year as there is danger of stimulating too much wood growth if all of the top be removed in one season. Part of the top must also be left to elaborate food for the newly placed scions.

It is a simple matter to thus change the variety of a tree and sometimes it is very profitable. Ninety per cent. of the scions will grow even when placed by a person who has never done the work before. Every worthless variety and crab which is left in the orchard after thinning should be top worked.

A PERSONAL WORD TO THE FRUIT GROWER

The Department of Horticulture of the Purdue University Agricultural Experiment Station is constantly investigating and studying the orchard conditions of the state. The apple growers of Indiana are confronted with a number of problems, which the Department of Horticulture desires to help them solve. All fruit growers of the state are invited and urged to bring their troubles to the Horticultural Department. Every assistance possible will be gladly given to enable each fruit grower to help himself. Experiments are always being carried on and many times the results throw direct light on the individual difficulty of the fruit grower.

This is a personal invitation for you to get acquainted with the Department. Write for information and come to the Station whenever possible.

SUMMARY

I. History and Present Status of Indiana Apple Growing pages 3 to 12

The apple has been grown successfully in Indiana for nearly a hundred years. In the early days there were few pests for the grower to contend with, but as more orchards were set and the forests felled, the enemies of tree and fruit began to appear and to cause more damage. Many of the insects and diseases were borne with the increasing stream of travel from the older settled states of the east. The abundant farming opportunities of the

state tended to prevent early specialization in fruit growing and hence not much effort was made to combat the multiplying pests. Information was scant and remedial measures not at hand if the earlier growers had looked for them. The operation of these causes for a long period of years resulted in the gradual neglect and abandonment of many promising orchards, notwithstanding the excellent natural advantages of the country. Within the last 35 years, careful studies have been made of nearly all the apple pests and control measures brought to a high degree of efficiency. The present possibility of protecting the tree and fruit from insects and diseases has given new impetus to the business and has put apple growing on a commercial business basis more than ever before, making it an attractive investment for the capitalist. So far as Indiana is concerned, the commercial spirit pervading present day apple growing is justified because:

The history of the apple in Indiana and the experience of up-to-date growers prove that the fruit thrives.

Nearly every county in the state possesses come land suitable for growing apples on a commercial scale. Indiana apples are unsurpassed in quality.

Insects and diseases can be successfully controlled by modern methods.

The price of desirable apple land is relatively very low.

Transportation facilities are excellent and transportation rates low compared with some other noted apple growing localities.

On account of the large profits which may be and are being made in commercial apple growing in Indiana, there is likely to be a tendency on the part of some to engage in the business hastily and without sufficient technical knowledge to avoid mistakes. The vigorous development of the business is justified by the conditions but its exploitation would be unfortunate. Technical skill, good judgment and business sense are essential parts of the equipment of the successful commercial grower; lacking any of these, failure is likely to ensue.

II. The Young Orchard page 25

Conditions for apple growing in different parts of the state.

Some of the points to consider in selecting a location are,—proximity to a good shipping point, transportation service, good roads and short haul, labor supply and presence of other commercial orchards page 29

The soil should be strong, undepleted of its store of available plant food, well drained, fairly deep and not underlaid by an impervious hard pan page 32

The site should be elevated to secure good air drainage..page 34

Varieties should be selected with reference to their adaptability to local conditions, to the market they are expected to supply, to the taste of the grower, and for the commercial orchard, should usually be not over five or six in number and should be confined to sorts of established merit page 37

For northern Indiana, the following varieties are recommended for commercial planting: Baldwin, Grimes, Hubbardston, Jonathan, Maiden Blush, Northern Spy, Oldenburg, Rome Beauty, Stayman, Wagener, Wealthy and Yellow Transparent. For southern Indiana the following are recommended: Akin, Ben Davis, Benoni, Gano, Grimes, Jonathan, Oldenburg, Rome Beauty, Stayman, Wealthy, Winesap, Yellow Transparent, York Imperial. Descriptions page 42

Spring setting is usually more desirable than fall setting. page 46

Details of nursery practice in regard to various methods of propagation are of less interest to the orchardist than to the nurseryman. The planter has a right to demand trees that are well grown, true to name, of good size and shape for the age and variety, free from all dangerous insects and diseases and properly cared for from the time they are dug until they are turned over to him page 48

One or two-year trees only should be set.....page 51

Details of setting page 53

The square or the alternate plan of setting is recommended. page 55

Fillers may be profitably used if removed in time.....page 55

In most commercial orchards the trees are too close together. The permanent trees should not be less than 35 feet apart. On strong, heavy soils, 40 to 50 feet is better.....page 58

Preparation of soil page 59

Planting methods page 61

III. Pruning page 63

The newly set tree should be pruned at once if set in the spring. If fall set, the initial pruning is deferred till the next spring. This first pruning is the most important the tree ever receives as it determines, to a great degree, the future shape of the top and does a great deal to insure a vigorous growth the first season page 63

The second year's pruning consists in a heading in of long growths and removal of superfluous branches to keep the top open page 65

The mature tree should receive a light pruning every year.

Pruning is sometimes practiced for special purposes such as inducing fruit bearing, control of diseases, etc.....page 69

The pruning tools are important. Cheap tools are undesirable. The outfit should include good saws, lopping shears and hand shears or, for young trees, the old style pruning knife.

The heavy pruning is done in late winter and early spring. All cuts should be close and clean and should be parallel to the main limb. Large wounds should be protected page 71

IV. Orchard Management page 73

Clean culture with cover crops is probably the best system of orchard management on all lands which are not too rough for safe cultivation page 73

Cover crops page 76

On the rougher orchard sites the trees should be thoroughly mulched from the start page 76

Double cropping is sometimes profitable in the cultivated orchard, provided the market for the secondary crop is easily accessible and the labor supply cheap and adequate.....page 78

Young trees usually need some protection from rabbits, mice and other rodents. Many washes are available and are effective for a time. A good mechanical protector is best...page 81

The barrel and the box are the principal commercial packages. The box is universally used in the west and will be used more in the central states in the future for fancy grades of apples. Growers should begin to study and practice box packing....page 84

V. Spraying page 86

The commercial apple grower should be familiar with the principal insect and disease pests of the orchard.....page 86

Dormant spraying is practiced if the scale is present. Lime-sulphur wash should be used at a specific gravity of 1.03 to 1.04 or about 5 degrees Baume page 87

Dilute lime-sulphur wash as a partial substitute for Bordeaux is now past the experimental stage and is recommended in place of Bordeaux for the control of a number of apple diseases..page 87

The orchard should be sprayed with a combined fungicide and insecticide just before the blossoms open, just after the petals fall, two to three weeks after petals fall and about eight weeks after petals fall page 90

For summer use the lime-sulphur spray should be used at a strength of about 1.007 specific gravity or one degree Baume.page 90

Making of Bordeaux mixture page 92

A concentrated lime-sulphur solution can be made at home which will test 25 degrees to 26 degrees Baume, which can be stored and kept till desired and which is just as good as the commercial concentrate, except that, being not quite so strong,

it requires less dilution. The cost of the home-made concentrate is considerably less than the cost of the ready made material page 95

Formula for making home-made concentrate: 36 pounds pure lime (CaO), 80 pounds high grade sulphur and 50 gallons of water, boiled one hour page 94

The hydrometer should be used in determining the density of lime-sulphur solution and in making dilutions to spraying strength page 96

The commercial apple grower must have an adequate and efficient spraying outfit. The heavy horizontal pumps are recommended for the smaller orchards and power outfits for those 10 acres or more in extent page 99

VI. Renewal of Old Orchards.....page 102

If Indiana is to take its proper position as an apple state the old orchards, should be reclaimed page 102

Present conditions in many localities are deplorable and unnecessary and are due solely to ignorance and neglect on the part of the orchard owner. If the orchard is worth renewing it should receive attention; if not, it should be cut down. Some of the factors contributing to the poor condition of many old orchards are close planting, poor soils, double cropping, lack of cultivation, neglect of pruning, neglect of spraying and poor site page 103

If renewal is decided upon, the varieties should be determined, a plot of the orchard made, dead and dying trees removed, healthy specimens of worthless varieties top worked, the remaining trees pruned and sprayed and the soil plowed, fertilized and cultivated pages 103 to 113

Appendix page 118



Fig. 72. The proper end of the unprofitable orchard

APPENDIX

It is the purpose of this appendix to give the addresses of various firms which handle materials needed by the commercial horticulturist.

Horticultural Publications

Better Fruit, Hood River, Ore.
The Fruit Grower, St. Joseph, Mo.
The Rural New Yorker, New York, N. Y.
The National Horticulturist, Council Bluffs, Ia.
The Chicago Packer, Chicago, Ill.
The Fruit Trade Journal, (western edition) New York, N. Y.
The Fruit Magazine, Vancouver, B. C.
The Fruit Belt, Grand Rapids, Mich.

Reference Books

Macmillan Co., Chicago, Ill.
The Pruning Book, Bailey
The Principles of Horticulture, Bailey
The Nursery Book, Bailey

Orange Judd Co., Chicago, Ill.
The American Apple Orchard, Waugh
Harvesting, Storing and Marketing of Fruits, Waugh
The American Fruit Culturist, Thomas

Doubleday, Page and Co., Garden City, L. I.
How to Make a Fruit Garden, Fletcher

Wiley and Sons, New York, N. Y.
American Horticultural Manual, two vols., Budd and Hansen

J. B. Lippincott, Philadelphia, Pa.
Insects Injurious to Fruits, Saunders

The Fruit Grower, St. Joseph, Mo.
The Fruit Grower's Guide Book

William Briggs, Toronto, Ont.
The Canadian Apple Growers' Guide

Ginn and Co., Chicago, Ill.
Soil Fertility and Permanent Agriculture, Hopkins
Fungous Diseases of Plants, Duggar

Pruning Tools

Detroit Shear Co., Detroit, Mich.
Henry Disston and Sons, Philadelphia, Pa.

Atkins Saw Co., Indianapolis, Ind.
Vaughn Seed Store, Chicago, Ill.
Peter Henderson, New York, N. Y.
Henry Dreer, Philadelphia, Pa.
Simons Hardware Co., St. Louis, Mo.

Manufacturers of Spray Machinery

American Sprayer Co., Minneapolis, Minn. (general)
Bateman Mfg. Co., Grenlock, N. J.
The Bean Spray Pump Co., Cleveland, O. (general)
The E. C. Brown Co., Rochester, N. Y.
Cushman Power Sprayer Co., Lincoln, Neb. (power outfits only)
The Deming Co., Salem, O. (general)
R. H. Deyo Co., Binghampton, N. Y. (power)
Field Force Pump Co., Elmira, N. Y. (general)
The Friend Mfg. Co., Gasport, N. Y. (general)
The Goulds Mfg. Co., Seneca Falls, N. Y. (pumps)
The Hardie Mfg. Co., Hudson, Mich. (general).
Latham and Co., Sandusky, O. (compressed air)
F. E. Meyers and Bro., Ashland, O. (pumps)
Morrill & Morley, Benton Harbor, Mich. (barrel pumps)
The New Way Motor Co., Lansing, Mich. (power)
Niagara Gas Sprayer Co., Middleport, N. Y. (carbonic-acid gas)
The Sandusky Foundry and Machine Co., Sandusky, O. (compressed air)
Spramotor Co., Buffalo, N. Y. (general)
The Star Brass Works, Chicago, Ill. (general)
Wm. Stahl Sprayer Co., Quincy, Ill. (barrel pumps)

Manufacturers of Spray Materials

General

The Grasselli Chemical Co., Cleveland, O., and Chicago, Ill.
The Toledo-Rex Co., Toledo, O.
The Sherwin-Williams Co., Cleveland, O., Chicago, Ill.
Thomsen Chemical Co., Baltimore, Md.
The Vreeland Chemical Co., New York, N. Y.
Bowker Insecticide Co., Boston, Mass.
B. G. Pratt Co., New York, N. Y.
Henry Heil Chemical Co., St. Louis, Mo.
Merrimac Chemical Co., Boston, Mass.
Kentucky Tobacco Products Co., Louisville, Ky.

Sulphur

A. Kiefer Drug Co., Indianapolis, Ind.
The Daniel Stewart Co., Indianapolis, Ind.
Ft. Wayne Drug Co., Ft. Wayne, Ind.
T. and S. C. White Co., New York, N. Y.
John C. Wiarda and Co., Brooklyn, N. Y.

Copper Sulphate

Fergusson Brothers, Philadelphia, Pa.
John C. Wiarda and Co., Brooklyn, N. Y.

Lime[1]

Delphi Lime

Analysis:

Calcium oxide (Ca O)	38.59
Magnesium oxide (Mg O)	31.76
Clay	26.63
Silica ($Si O_2$)	.14
Loss	2.88
	100.00

Delphi Lime Co., Delphi, Ind.
Harley Bros. Lime Co., Delphi, Ind.
Coble Lime Co., Delphi, Ind.

Huntington Lime

Analysis:

Calcium oxide (Ca O)	63.03
Magnesium oxide (Mg O)	34.15
Ferric oxide and alumina ($Fe_2 O_3 + Al_2 O_3$)	2.63
Silica ($Si O_2$)	.07
Moisture	.13
	100.00

The Western Lime Co., Huntington, Ind.
The Consolidated Lime Co., Huntington, Ind.
E. S. Wheeler, Huntington, Ind.

[1] Analyses and addresses taken from the 28th annual report of the State Geologist, 1903

Milltown Lime

Analysis:

Calcium oxide (CaO)	98.24
Magnesium oxide (MgO)	.56
Ferric oxide and alumina ($Fe_2O_3 + Al_2O_3$)	.42
Insoluble residue	.30
Moisture	.54
	100.06

J. B. Speed and Co., Louisville, Ky.
Eichel Lime and Stone Co., Milltown, Ind.

Salem Lime

Analysis:

Calcium oxide (CaO)	96.93
Magnesium oxide (MgO)	.85
Silica (SiO_2)	2.22
	100.00

The Union Cement and Lime Co., Louisville, Ky.

Mitchell Lime

Analysis:

Calcium oxide (CaO)	97.712
Magnesium oxide (MgO)	1.150
Ferric oxide and alumina ($Fe_2O_3 + Al_2O_3$)	.328
Insoluble residue	.418
Carbonic oxide (CO)	.319
Undetermined	.073
	100.000

The Mitchell Lime Co., Mitchell, Ind.

Bedford Lime

Analysis:

Calcium oxide (CaO)	98.40
Magnesium oxide (MgO)	.10
Ferric oxide and alumina ($Fe_2O_3 + Al_2O_3$)	.52
Insoluble residue	.78
	98.80

The Horseshoe Lime and Cement Co., Bedford, Ind.

Seed Firms Handling Cover-crop Seed

Crabbs-Reynolds-Taylor Co., Crawfordsville, Ind.
Ohio Valley Seed Co., Evansville, Ind.
Livingston Seed Co., Columbus, O.
Garton-Cooper Seed Co., Chicago, Ill.
L. L. Olds Seed Co., Madison, Wis.
Vaughn Seed Store, Chicago, Ill.
Wood-Stubbs and Co., Louisville, Ky.
J. Chas. McCullough, Cincinnati, O.
Barteldes Seed Co., Lawrence, Kan.
Northrup-King Co., Minneapolis, Minn.

Apple Package Firms

Hanna-Brackenridge Co., Ft. Wayne, Ind.
Indiana Cooperage Co., Evansville, Ind.
G. W. Hill and Son, Indianapolis, Ind.
The Indiana Cooperage Co., Indianapolis, Ind.
The Vail Cooperage Co., Ft. Wayne, Ind.
Wm. K. Noble, Ft. Wayne, Ind.
National Manufacturing Co., Detroit, Mich.
J. P. Fellers and Co., Lyons, O.
Forrester-Nace Box Co., Kansas City, Mo.
St. Louis Basket and Box Co., St. Louis, Mo.
G. P. Read, New York, N. Y.
The Pierce Williams Co., South Haven, Mich.
Nettleton Box and Lumber Co., Kansas City, Mo.

Commission Firms

Chicago

Gibson Fruit Co.
C. H. Weaver and Co.
Geo. Middendorf Co.
Barnett Bros.
Coyne Bros.
Crutchfield, Woolfolk and Clore
Snyder, Schutz and Co.
Peters Bros.
Hall, Wedge and Carter

Indianapolis

Geo. Hitz and Co.
Nondersaar and Co.
Hurd and Fuchs
John W. Newmann and Co.
Jas. Mascare
Geo. W. Cummins and Co.
Jas. L. Keach
E. F. Schideler and Co.

Cincinnati

John Curren and Co.
Weil-Brockman Co.
M. Fugazzi and Co.
F. J. Noble
I. M. Price and Co.
Joseph Gentile and Co.

John Minges and Co.
L. F. Gloystein and Co.
Henry Ransick and Sons
J. A. Massa and Co.
F. Pieper and Co.
Amhose Kyte and Co.
F. Herrier and Co.
Armacost Riley and Co.

Louisville
Velter Bros.
Harshfield Bros.
Theo. Shoptaw and Co.
James J. Flynn
Casper Gargotto and Co.
Hardin, Hamilton and Lewman
W. A. Smith and Sons
Peacock and Van Buren
Jos. Denunzio Fruit Co.
E. H. Bowen and Co.
Hynes and Co.
Leisman Co.

St. Louis
Scalzo-Fiorita Fruit Co.
A. S. Blick and Co.
M. J. Whelan and Co.
Conrad O. Schopp Fruit Co.
M. Longo Fruit Co.
The Fruit Supply Co.
P. M. Killy and Co.

Cold Storage Firms

Chicago
Gibson Fruit Co.
Western Cold Storage Co.
Monarch Cold Storage Co.
North American Cold Storage Co.

Indianapolis
The Indiana Refrigerating Co.
Holt Ice and Cold Storage Co.

Cincinnati
Cincinnati Ice Mfg. and Cold Storage Co.
Merchants Ice and Cold Storage Co.

Louisville
Merchants Ice and Cold Storage Co.

St. Louis
The St. Louis Refrigerator Cold Storage Co.
The Mound City Ice and Cold Storage Co.

Indiana
Ebner Ice and Cold Storage Co., Vincennes
Ebner Ice and Cold Storage Co., Seymour
Ebner Ice and Cold Storage Co., Washington
The South Bend Cold Storage Co., South Bend
The Evansville Ice and Storage Co., Evansville
The Indiana Springs Co., Kramer
Inman Ice and Storage Co., New Albany
City Ice and Cold Storage Co., Muncie

Brazil Ice and Storage Co., Brazil
New Albany Ice Co., New Albany
Vigo Ice and Cold Storage Co., Terre Haute
Holt and Brandon Ice and Cold Storage Co., Evansville

Horticultural Organizations in Indiana

Indiana Horticultural Society, C. G. Woodbury, Sec., Lafayette
Marion County Horticultural Society, J. J. Milhous, Sec., Valley Mills
St. Joseph County Horticultural Society, May S. Rose, Sec., Mishawaka
Fairmount Horticultural Society, Mrs. Rachel Lewis, Sec., Fairmount
La Grange Agricultural and Horticultural Society, A. H. Bogue, Sec., La Grange
Wayne County Agricultural and Horticultural Society, Walter Ratliff, Sec., Richmond
Jefferson County Horticultural Society, L. E. Hitz, Sec., Madison
Noble County Horticultural Society, John W. Moorhouse, Sec., Albion
Cass County Horticultural Society, Slate Kline, Sec., Logansport
Laporte County Fruit Growers' Association, Wm. M. Walton, Jr., Sec., Laporte
Akron Fruit and Vegetable Growers' Association, R. N. Gast, Sec., Akron

If you do not already belong to the society in your community, join at once. If there is no society there, organize. There is no better way to keep up with the always advancing horticultural science than by being a member of some live horticultural organization. The Secretaries of the various organizations are always glad to give information in regard to membership, dues, etc.

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 31

LaFayette, Ind., January, 1912

AGRICULTURAL EXTENSION

XIV

SMALL SEED IMPROVEMENT

All progressive farmers are now taking a keen interest in seed improvement, since due attention to this factor of crop production has been found to very materially increase yields of field crops.

Clover, alfalfa, and other forage crops are grown fairly extensively in Indiana. Much more of the leguminous crops, however, should be produced, since they are valuable stock foods and soil improvers.

Clover, alfalfa and grass seeds being so small, and the impurities and adulterants, apt to occur in them, so numerous, it is extremely difficult, without some study and practice, to accurately estimate the real value of various lots of these on the market and elsewhere. To assist all interested in these seeds, a Branch Seed Laboratory has been established by the Bureau of Plant Industry, U. S. Department of Agriculture, in cooperation with the Agricultural Extension Department, Purdue University, LaFayette, Ind.

Examinations, tests, and identifications of all small seeds, both field and garden, are made in the Laboratory and reports furnished promptly, without charge.

In the light of experimental and other evidence, it is now known that it pays well to use sound, pure, clean, vigorous seed on Indiana farms.

Have your seed tested!

SMALL SEED IMPROVEMENT

G. M. Frier Lovina S. Merick[1]

As experimental work in crop production advances, it becomes more and more strikingly evident that the character of the seed used has much more to do with the character of the resulting crop than is generally supposed. Through the various agricultural extension agencies, special educational trains, short courses, institutes, etc., much stress is being laid upon the importance of properly selecting, caring for, testing and grading of seed corn. This, beyond all question, is one of the important features of corn improvement, since it affects both the stand and quality of the corn, while these in turn affect yield. It is known to be easily possible to increase our average yield of corn many bushels by due attention to the matter of seed selection.

Experiments with different sorts of seed wheat have shown conclusively that the use of the fanning mill, to secure a plump, vigorous, clean grade of wheat for seed, makes a difference of four or five bushels per acre in the yield, a good yielding variety having first been secured. While there are other things that tend to increase our average production of wheat and corn, such as the question of varieties, rotation, fertilization, insects, plant diseases, etc., it is now recognized to be a fundamental principle of successful crop production that the seed must be of the best quality obtainable, clean, capable of germinating strongly, of a high yielding variety, and suitable to the conditions under which it is to be grown.

What is true of corn and wheat in regard to the importance of good seed is equally true of other grains and of forage crops. The underlying principle that like tends to beget like is centuries old, but it is as true as it is old, and, moreover, the older it gets the more widely understood and recognized does it become.

Among our most important field crops in addition to corn and grain are the clovers, alfalfa, and the grasses. The value of a clover or other legume in a rotation suitable for Indiana farms has long been urged and in a limited way has been recognized by our farmers. The importance of both the legumes and the grasses to the stock-feeder and the dairy farmer is also well known. Varying degrees of success have been achieved by those who have attempted to grow clover, alfalfa and the grasses, all of which, especially the legumes, have a very important bearing on soil improvement, as well as being most valuable stock foods.

[1]Detailed by Bureau of Plant Industry, U. S. Department of Agriculture

Many causes might be advanced for numerous complete failures to secure a good stand of clover or alfalfa. Poor seed not infrequently is the sole cause. In numerous instances poor seed is responsible for fair stands only, secured by farmers who looked for a thick mass of luxuriant clover or alfalfa.

Investigation as to conditions prevailing in the seed trade in Indiana, the importance farmers attach to good seed, and the sort of seed they are using, disclosed some startling facts.

1. Large quantities of inferior seed are offered for sale in this state.

2. Few outside of those who deal in small seeds exclusively are expert seedsmen and know good seed from poor seed. Even those whose sole business is the handling of seeds, know little about weed seed impurities, adulterants and the various factors that enter into the problem of selecting high class seed as opposed to inferior low grade seed.

3. Few seedsmen, indeed, give any attention to seed testing as an aid in determining the quality of the seed.

4. Many farmers demand a cheap seed, thinking it economy to purchase a medium or low grade of seed at $7.00 or $8.00 a bushel, rather than a high grade, clean, pure, strong seed at $9.00 or $10.00 a bushel. This class of farmers, in fact, attach more importance to the price of seed than to its quality.

5. There are those even who purchase tailings to sow in out of the way places, such as woods-pastures, and in soil more or less unsuited to regular cropping, with corn, wheat, etc.

6. There are numerous farmers who plant clover seed just as it comes from the huller, wheat as it comes from the threshing machine, and corn as it comes from the crib.

7. There are those who demand a high grade seed on the market, and are willing to pay a fair price for it, but who find it extremely difficult to secure just what they demand.

8. Far too little use, on the whole, is made of the fanning mill by farmers and seed dealers.

9. The use of poor seed is, in a large measure, responsible for the weed problem now confronting Indiana farmers.

In view of these facts and of the fact that all over this country there is a rapidly growing interest in small seed improvement, facilities have been provided at Purdue University for the testing of seeds for purity and germination, for making examinations of seeds for special purposes, for the naming of weed seeds occurring in, or apt to occur in commercial small seeds, and for the correct naming of crop seeds resembling each other closely.

Reports of all tests, examinations or identifications are sent out promptly. No charge is made for any work done in the Seed Laboratory.

Perhaps the most important reports sent out are those on purity and germination power of seed in samples submitted. A purity report shows several items of interest and value to the farmer or seed dealer:—

1. The different kinds of weed seed impurities occurring in the sample, the common English names being used in every instance.

2. Approximate number of weed seeds of each kind present per pound of seed of the sort represented by the sample sent.

3. Per cent., by weight, of pure seed. Just in this connection it should be remembered that a purity test may show a seed to be 98 or 99 per cent. pure, while at the same time it may be wholly unfit for use, owing to the presence of seeds of particularly undesirable weeds, such as dodder, or Canada thistle. The important consideration is—what impurities are present, how much of each, and what is the character of each?

4. Per cent. of inert matter, such as grit, chaff, broken stems, leaves, etc.

5. Kinds and quantities of seeds of some value present in sample other than those of which the sample is supposed to be composed. For instance, timothy is often found in alsike seed.

6. Number of weed seeds (including dodder, if present) which would be sown on each square rod of land if seed of the kind being reported upon were used.

The germination test report shows:

1. Per cent. of seed of the sort represented by the sample sent that will grow.

2. Per cent. of hard seed (in samples in which hard seeds occur)

3. Meaning and significance of the term "hard seeds." These facts regarding the quality of seed are indispensable to the farmer, or seed dealer who would know when seed should be rejected and when accepted, and who would know the real value of any given lot of seed.

All who have to do with the seed that is to be used on the farms of the state are urged to begin negotiations for seed, weeks before it is to be used, so that samples offered may be secured and properly tested before an order is placed.

In the taking of samples, care should be taken to secure a representative sample, that is, one fairly representing the lot from which the sample was taken. To get a representative sample, seed should be taken by means of a seed trier, from top, middle and bot-

tom of every sack if there are only a few in the lot, or from every second, third, fourth, fifth or sixth sack, and so on, according to how many sacks there are in the lot. A special seed trier is used for securing seed from top, middle and bottom of bins. Three or four tablespoonfuls of clover or alfalfa seed, or four or five of grass seed, are sufficient for a sample. Samples should be plainly marked with the name and address of the sender, and should be accompanied by a letter giving any particulars possible concerning the source of the seed, the quality it was represented to be, etc., and stating whether a purity or germination test or both are desired. If more than one sample is sent at one time, distinguishing marks, such as numbers, trade names, or letters should be put on them, so that reports can be associated with the right samples. All samples should be addressed Branch Seed Laboratory, Agricultural Extension Department, Purdue University, LaFayette, Ind. It is to be borne in mind constantly that it pays to go to considerable trouble in order to get a high grade of seed true to name, and capable of germinating in a strong way. It is also to be remembered that dealers will cater to the demand made upon them for seed, so that if cheap seed is demanded for the most part, as is frequently the case, or if, on the other hand, high grade seed is demanded, the dealers' supply will be in accordance with the demand. That it pays and pays well to use high grade seed there can be no question. That high grade seed cannot always be had is also true to a certain extent. This is due partly to the greed of gain of some seed dealers and partly to the failure on the part of the farmer to realize the importance of good seed as a factor in crop production. If farmers will demand a high grade of seed and take steps to secure a high grade of seed it will be increasingly easier as time goes on to get good seed. Here the Seed Laboratory plays an important part, for here is an opportunity to send in samples to be tested, to be identified, or examined for any special purpose and reported upon.

Those who became impressed with the importance of good seed as a means of increasing the yield and quality of their crops were largely instrumental in bringing about at Purdue University the establishment of a Seed Testing Laboratory, to which samples of such seeds as those of the clovers, grasses and other small seeds which are difficult to analyze, might be sent. This laboratory was established in February, 1910, and is at the disposal of anyone, anywhere, who will take advantage of this aid in the selection of good seed. Since the opening of the Laboratory in February, 1910, up to July, 1911, 1327 samples, including 30 from Ohio, five from Illinois, four from Kentucky, four from Georgia and one each from North Dakota and Alabama have been received. These samples

represent 46 different kinds of commercial seeds. Ten hundred and forty-two purity tests, 1119 germination tests, 111 identifications and nine examinations have been made. Not as much interest, however, is being taken in the Laboratory and its work by farmers and seed dealers as was expected, though extensive advertising of this free seed testing has been done. It is hoped that many more will avail themselves of this opportunity to get assistance in the selection of better seed during the coming season. Standards prevailing in the seed trade should be raised. Farmers have this pretty much in their own hands. To show the need of better conditions, note the following tables, with explanations, setting forth briefly observations made in the Laboratory as to a few features of seeds and the seed trade in Indiana:

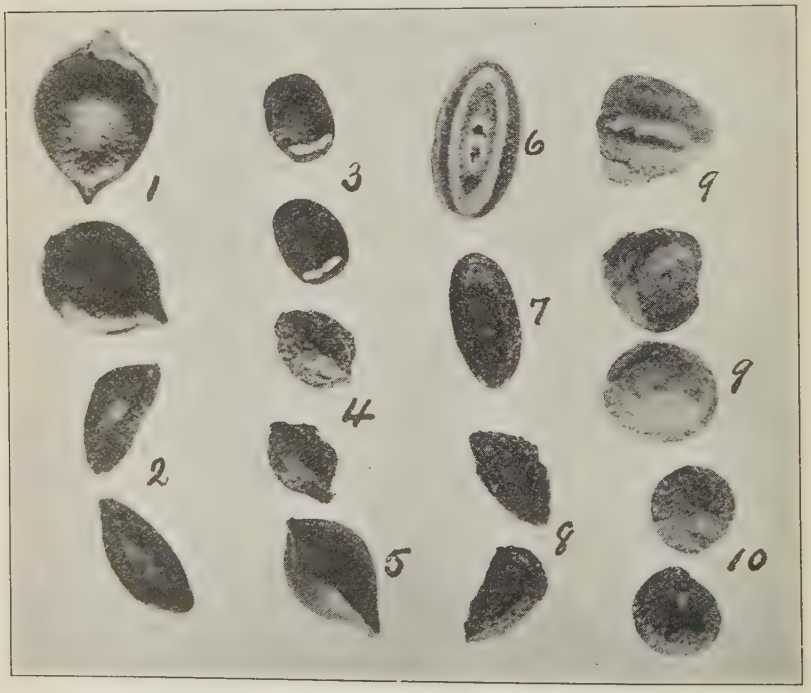


Fig. 1. 1. Smartweed 2. Black-seed plantain 3. Catnip 4. Sorrel 5. Dock 6. Bracted plantain 7. Buckhorn 8. Evening primrose 9. Russian thistle 10. Lamb's quarters

TABLE I.—SHOWING FREQUENCY OF OCCURRENCE OF THE SEEDS OF CERTAIN TROUBLESOME WEEDS IN SAMPLES ANALYZED

Name of weed seed	Number of times it has occurred in samples
Black-seeded plantain	507
Green foxtail	333
Sour dock	315
Buckhorn	256
Sheep sorrel	209
Pigweed	191
Ragweed	169
Five finger, or cinquefoil	152
Peppergrass	145
Yellow foxtail	142
Smartweed	142
Tickle grass, or old witch grass	132
Dodder	119
Small crab grass	115
Large crab grass	104
Evening primrose	100
Vervain	96
Night-flowering catchfly	66
Bracted plantain	64
Yellow trefoil	57
Wild carrot	56
Russian thistle	55
Wild sweet clover	54
Bitter dock	51
Whitetop	25

In all, 250 different kinds of weed seed impurities have been found in samples submitted at one time and another. The above are a few of common occurrence, in seed sold and used in this state. These impurities are found in varying quantities, from a few seeds to the pound, or what would seem but a few to the square rod or acre, to an amazingly large number per pound of seed of the

sort submitted. For a dozen or more impurities to occur in a single sample and each in considerable quantity is by no means uncommon. Twenty or 25 different kinds of weed seeds in a single sample, some of them in considerable quantities, is not rare. It is rare to be able to purchase on the market a bushel of seed wholly free from impurities and adulterations. In samples of seed which have been grown under very favorable conditions, and which have been very thoroughly cleaned, there may still, perhaps, be a few weed seeds and some inert matter. The fact remains, however, that there is room for very great improvement, both in the growing and in the handling of seed in Indiana. Much is heard at the present time about the serious weed condition existing in the state. This is in no small measure, due directly to the general low quality of seed used by our farmers, the large amount of weed seed impurities that have never been fanned or screened out of the clover, alfalfa or grass seed before depositing it in the soil. In the attempt, in a measure at least, to free fields of weeds, it is essential to purchase and use only high grade seed. To be able to determine just what seed is genuinely high grade one must either know seeds and the



Fig. 2. 1. Vervain 2. Dog fennel 3. Catnip 4. Night-flowering catchfly

character of the plants from which they come and be able to determine the quantity of impurities and adulterants present as well as the germination power of the seed, or send samples of seed to the Seed Testing Laboratory at Purdue, to be analyzed there, and reported upon. Progress in weed control or eradication will never be anything but very slow, unless more importance is attached to the matter of securing, in one way or another, clean, pure, vigorous, fresh seed. One thing among others that the Laboratory has done, is to show more definitely and clearly the relation between the conditions existing in the seed trade today, the farmers' attitude toward good seed, the weed situation and the production of the best of crops.

In connection with the Seed Laboratory work, it has been noticed that it is a common thing for various classes of seed on the market to bear trade names which are more or less misleading. For instance, we have such designations for seed as "Choice," "Prime," "Very Choice," "Extra Choice," "High Grade," "Fancy," "Extra High Grade," "Country Prime," etc., etc. The seed may or may not be of the quality implied by its name, as is shown by the following table:

TABLE II.—TRADE NAME AND PRICE DO NOT ALWAYS INDICATE THE QUALITY OF THE SEED OFFERED

Name of seed	Trade name	Price paid per bushel	Per cent. pure	Per cent. inert matter	Per cent. foreign seed	Per cent. germination
Red clover	High Grade	$ 9.00	98.50	0.93	0.57	71.5
Red clover	Very Choice	10.00	99.51	0.39	0.10	91.5
Red clover	High Grade	8.00	99.45	0.55	0.00	94.0
Red clover	Country Prime	7.75	99.17	0.30	0.53	92.5
Alfalfa	Prime	10.00	99.19	0.53	0.28	73.5
Alfalfa	High Grade	12.00	99.55	0.43	0.02	66.5
Kentucky blue grass	High Grade	2.00	79.28	19.48	1.26	79.5
Kentucky blue grass	High Grade	3.00	36.90	35.63	27.47	29.0
Kentucky blue grass	Ky. Fancy	2.50	81.64	17.68	0.68	54.5
Kentucky blue grass	Good Grade	2.00	72.94	26.38	0.68	35.5
Alsike	High Grade	8.50	98.04	0.48	1.48	79.75
Alsike	Best Grade	10.00	92.76	1.11	6.13	70.75

In the above table comparison between any two samples almost may be made and it is apparent that there is not anything like a

constant and uniform relation between trade name, price and actual quality. Compare "Very Choice" seed at $10.00 with the "High Grade" at $8.00. The difference is slight except that the lower priced seed is somewhat higher in germination power than the higher priced seed, while the percentage of pure seed is practically the same in each. Again, compare the two alfalfa samples and the same thing will be seen. In the case of the blue grass we find the widest variation in quality, no indication of this, however, being evident from the names, at least so far as the farmer is concerned. The market prices of seed fluctuate from time to time, it is true. This, however, is but a further indication of the unreliability of price as an indication of quality. It is safe to say that conclusions as to quality cannot and ought not to be based on trade name and price, though the higher priced seed is more likely to be the better seed. It is to be understood, however, that as a rule the low priced seed is likely to be low grade, and that to purchase a low priced seed knowing it to be low grade is very poor economy indeed. There are many who make a practice of purchasing a very low grade of seed and sometimes even tailings to sow in outlying places, such as woods pastures, etc., forgetting that such spots are then hotbeds for the propagation of enormous quantities of weeds which will spread rapidly to other parts of the farm. Low grade seed is expensive at any price, no matter how small. It pays to secure a high grade of seed, though it costs more. It is, in fact, worth more and the wise farmer will gladly pay a little more for the extra trouble to which the dealer or some one else has gone to separate the weed seeds and trash from the good seed, thereby making a quality of seed from which a good crop may be expected, other things being right as well. The thing is, however, to determine the actual quality of the seed offered, whether the price is $8.00, $9.00 or $10.00. Here is where the Seed Laboratory comes in useful, and just here is seen the advisability of getting samples early so that tests can be made and good seed secured.

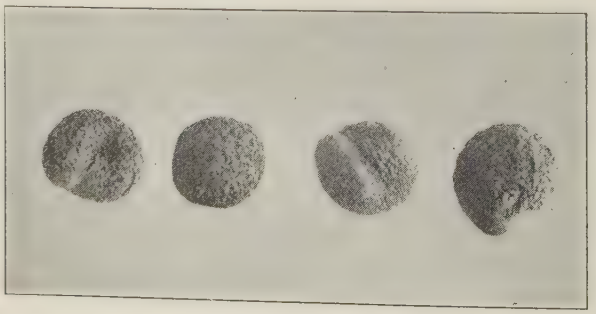


Fig. 3. Dodder

From the work done in this Laboratory and a few calculations made, it is plain that when low grade seed is bought, a very high price is in reality paid for the good seed actually contained in such low grade stuff, and that in addition much that is undesirable in the highest degree is present. Examine the following table for instance, which shows the analyses of a number of low grade lots of seeds, and the prices actually paid for the good seed these contained.

TABLE III.—ANALYSES OF LOW GRADE SEED, ACTUAL COST OF GOOD SEED

	Red Clover		Alfalfa		Timothy	
	1	2	1	2	1	2
Per cent. germination	23.00	60.50	56.00	55.00	86.75	62.25
Per cent. purity	76.03	76.98	94.77	97.64	96.82	97.90
Per cent. inert matter	10.88	1.99	2.90	1.92	1.29	1.86
Per cent. foreign seeds	13.09	21.03	2.33	0.44	1.89	0.24
Number of kinds of weed seeds	34	26	19	5	12	5
Number of weed seeds per pound of sample	56,070	187,470	6060	930	15,400	2250
Actual cost per bushel of pure seed that would grow	$40.03	$15.03	$18.84	$20.48	$2.68	$3.66

Here are shown the analyses of two samples each of red clover alfalfa and timothy. Note that these low grade samples are all low in vitality, a feature which probably was not evident from merely looking at the seed. Mouldiness, a much shriveled or sprouted condition is of course easily seen. Apart from these features it is impossible to more than make a guess at the vitality of seeds, unless a proper germination test is made. Note also the large number of kinds of weed seeds present in most of the samples. The red clovers are particularly poor in that they contain 34 and 26 kinds of weed seeds, and 56,070 and 187,470 weed seeds, respectively, per pound of crop seed. While the market price of each sample of red clover seed was $7.00 it will be noticed that only a small part of this seed in either sample would grow, that a large per cent. of the samples was grit, broken stems, weed seeds and other trash. It might be added that both these samples and the alfalfa samples in addition contained dodder. It will easily be seen that when one buys this sort of seed he is getting for his money little that is good, and a large amount of material that is worse than useless. To get a bushel of good live seed

from seed of this quality, one would have to spend $40.03 in the case of sample 1 of red clover seed, and $15.03 in the case of sample 2 of red clover. Now if one were to buy more of this sort of seed in order to scatter on each square rod the number of live seeds necessary to produce a good stand of clover, he would at the same time be increasing the quantity of weed seeds scattered on the land. It is needless to follow further the results of buying low grade seed. From the point of view of crop returns, it is the height of folly to buy low grade seed, if by any means good seed can be had, and it is usually possible if one goes at it in the right way. Here the Seed Laboratory can be of assistance and use to the farmers and seed dealers in helping to get at the real grade and value of seed offered for sale.

TABLE IV.—ANALYSES OF HIGHER GRADE SEED, ACTUAL COST OF LIVE SEED

	Red Clover		Alfalfa		Timothy	
	1	2	1	2	1	2
Per cent. germination	91.50	93.00	87.50	94.50	94.50	97.50
Per cent. purity	99.51	98.08	98.32	99.04	98.61	99.58
Per cent. inert matter	0.39	1.49	1.09	0.67	0.93	0.42
Per cent. foreign seeds	0.10	0.45	0.59	0.29	0.46	0.00
Number of kinds of weed seeds	3	3	7	4	7	1
Number of weed seeds per pound of sample	360	270	1530	1080	4000	200
Actual cost per bushel of pure seed that would grow	$10.98	$9.32	$13.95	$12.29	$2.68	$2.56

Analyses of a few of the better class of samples reveal something very different—high germination and purity percentages, low inert matter percentages, a more reasonable weed seed content. In the great majority of samples there will always appear a few weed seeds, and a small amount of inert matter. A sample giving a 98 per cent. or 99 per cent. purity test and an equally high germination test, however, should not be used if it contains any of such noxious seeds as dodder and Canada thistle, and the like.

It is important to note carefully the character of the impurities present, as well as other features of the seed. It may be added that no dodder was found in any of the better class of samples shown above. A comparison of the market price of each of these samples and the actual cost of the pure, live seed contained in them shows that in the purchase of seed of this sort, there is but little waste,

and comparatively little likelihood of helping in the propogation and spread of weeds.

The work of the Seed Laboratory abundantly emphasizes the importance of a free and extensive use of the fanning mill. This implement is neglected to far too great an extent as is shown in the character of our fields, many of our crops, and the samples examined in the Laboratory. The fanning mill, like the cream separator or the Babcock tester, or the manure spreader, is an implement that is in most instances indispensable and a paying investment and should be owned, if not by every farmer, then at least by groups of farmers throughout the state. A good fanning mill would much more than pay for itself in a short time. It is extremely useful in cleaning up and preparing for use all the small seeds used on the farm.

In order that the growing of field crops, especially of clover, alfalfa and the grasses, may be more successful, Indiana farmers are urged to study the question of good seed as a factor in crop production, so that its importance may be appreciated. Learn to know the distinguishing features of good and poor seed, use the Seed Laboratory to the fullest extent, and even learn to know weed seed impurities and common adulterants, and to make home germination tests.



Fig. 4. Showing a home purity test

It may be necessary, sometimes, for a farmer or seed dealer, to make home purity or germination tests. A fairly satisfactory purity test may be made as follows:

Secure a sample of seed fairly representing the bulk lot, using, if possible, a seed trier as already explained. Mix this thoroughly with a spatula or knife. Take a tablespoonful of this seed and separate into pure seed, weed seed, adulterants (if these can be recognized) and inert matter, such as grit, chaff, broken stems, etc. Estimate as nearly as possible the proportion of each of these constituents. Identify each kind of weed seed and note the quantity of each. A little calculating will give a rough idea of the number of each sort of seed that would be scattered on a square rod or an acre, if seed of the kind being examined were sown. If suitable scales are available the work can be done much more accurately. Some study of weeds, weed seeds and other impurities is necessary if this work is to be of real value.

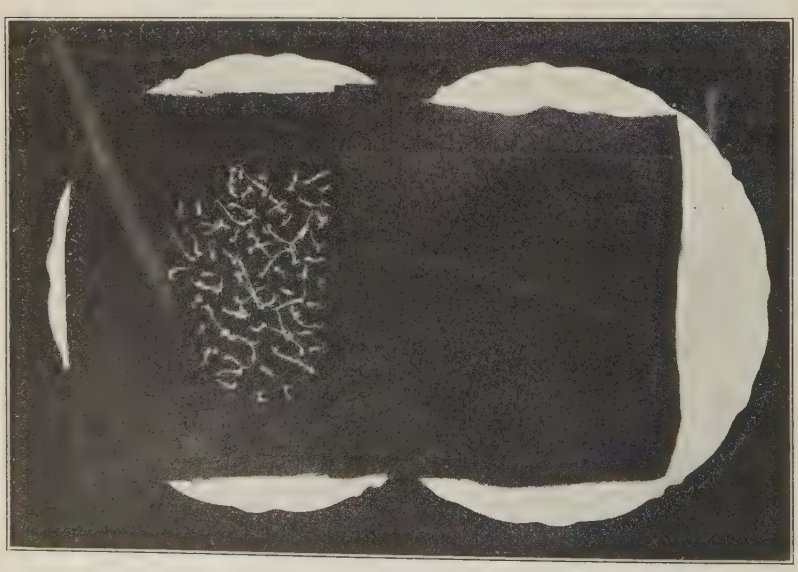


Fig. 5. Home germinator

To make a germination test of seed, count out 100 seeds from the pure seed pile. Take two ordinary dinner plates and a piece of Canton flannel twice as long as the diameter of one of the plates. Dampen it thoroughly and lay on a plate. Scatter the seeds on the part of this cloth which rests on the plate, no two seeds touching. Fold the other half of the flannel over the seeds, invert the second

plate over the first, and place in a room in which the temperature does not fall below 55 degrees at any time. In two or three days count and remove the sprouted seeds. Count and remove similarly each day thereafter, till the end of the sixth or seventh day. Suppose that in all, 90 seeds have germinated. The seed is then said to have a germination power of 90 per cent. It is scarcely practicable for any except experts with the proper facilities to attempt to make germination tests of the grass seeds.

To be able to make home purity and germination tests of small seeds is often of great advantage, as may be readily understood. Bulletin No. 428 of the Bureau of Plant Industry, U. S. Department of Agriculture, is extremely useful for those who desire further details as to small seeds and small seed testing.

In the interest of better clover and grass crops and a higher standard for Indiana agriculture, every farmer should avail himself of all opportunities to acquire a wider knowledge of the subject of good seed and the essential differences between low and high grade seed, so that he may buy intelligently and have much greater success with clover, grass and other crops.

PURDUE UNIVERSITY
Agricultural Experiment Station

Circular No. 32

LaFayette, Ind., January, 1912

AGRICULTURAL EXTENSION
XV

CANADA THISTLE AND ITS ERADICATION

A. G. Johnson[1]

Canada thistle (*Carduus arvensis* (L.) Robs.) is one of the worst weeds to eradicate when once it becomes established. The greatest care should be taken to avoid introducing it, and every effort put forth to eradicate it where it has already found a foothold.

THE PLANT AND ITS HABITS

Canada thistle is a perennial plant, that is, it grows an indefinite number of years from the same root system. The root is of the underground, running root-stock type. At varying depths in different types of soil, and under varying conditions, these cylindrical running root-stocks, almost white in color, and one-fourth inch or more in diameter, are sent out from the main upright root. On these root-stocks, at varying intervals, buds are developed from which new upright shoots are thrown up, and above ground these develop other upright flowering shoots. When broken up by farm implements, the pieces of the root-stock have the ability of starting new plants, and where they are dragged about they start new centers of growth. The shoots that are thrown up from the root-stock early in the season, develop upright flowering shoots that same year, while those that are thrown up late in the season remain in the rosette stage until the next season, when they develop upright stalks, which bear the flowering heads. From the character of the

[1]Resigned

underground root-stock, Canada thistle is found in more or less dense patches, of greater or less area according to the age of the patch, and other factors favorable or unfavorable for its development. This character of growing in patches and spreading by underground root-stocks is one of the easiest ways to distinguish Canada thistle from other thistles. Other thistles such as the common Bull thistle, grow usually only one in a place and have a single tap-root without underground side shoots, from which new plants arise, as with the Canada thistle.



Fig. 1. Canada thistles, showing horizontal running root-stock with young plants developing from it on either side of the old mature flowering plant. After Dewey in Circular No. 27, U. S. Department of Agriculture

Above ground the Canada thistle grows to a height of from one to three feet, or a little more, never attaining a height of five, six or seven feet as some other thistles do. The stem branches freely above, and at the ends of the ultimate branchlets the flowering heads are produced in mid-summer. The flowering heads are about an inch or less in diameter and about the same height. The heads are made up of numerous, minute flowers, rose-purple or lighter in color, densely crowded together and surrounded by rather soft-pointed, green bracts, which form the outer and lower part of the head.

In regard to seed bearing, there are two forms of the Canada thistle. While both forms have similar flowering-heads, as well as being similar otherwise, one form bears seeds and the other does not. The latter is known as the staminate or male form and in its heads no seeds are produced. The former is known as the pistillate or female form, which usually produces seeds, especially northward. Southward, perfect seeds are not produced so commonly. The seeds, which are about one-eight of an inch in length, are oblong in outline, often slightly curved, pointed at the lower end, narrowed above into a circular collar within which is a small projection. In cross section they are more or less angular. The surface is smooth and light brown in color. The seed is introduced into the fields with low grades of grass or clover or other seeds or carried by wind or



Fig. 2. Canada thistle, showing some of the details: *a*, portion of main stem with leaf; *b*, flowering head surrounded by soft-pointed green bracts; *c*, seed with downy tuft which causes it to float in the air; *d*, seed with tuft detached, enlarged. After Dewey in Circular No. 27, U. S. Department of Agriculture

water and thus the pernicious weeds get a start. All of these ways should of course always be guarded against to the greatest degree possible. When once in the fields, the weed spreads into patches by its underground root-stocks, and these root-stocks are broken and dragged to new territory by the plow, etc., where new plants are started. This should also be guarded against.

ITS INTRODUCTION AND DISTRIBUTION

The Canada thistle is a native of Europe, where it has been a pernicious weed since early times. It is thought by some that it was first introduced into Canada by the early French settlers. Doubtless it was independently introduced into New England also, by the early colonists there. It seems to have been recognized as a pernicious weed first in Vermont where it caused much alarm as early as the latter part of the eighteenth century, and laws were passed for its destruction. Other states have followed, at various intervals, with similar laws.

The weed has kept on spreading, nevertheless, both in Canada and the United States through native grown and imported seeds and otherwise, so that now it occurs throughout the northern states and a large part of Canada. In Indiana it is most troublesome in the central and northern portion. It is not commonly found in the southern part of the state, nor is it likely to prove troublesome there. It is a plant that seems to prefer more northern conditions.

METHODS OF ERADICATION

No set "best" method for the eradication of Canada thistle can be given. There are several ways, and the ones best suited to the conditions prevailing must be adopted. Different soil conditions necessitate different methods of treatment. In some soils it is more persistent than in others. The system of farming followed, where the thistle occurs, also enters into the problem, that is, as to whether or not smother crops and cultivated crops for instance, and which ones, can be used to advantage. In any case, the success of the method used is very largely dependent upon the intelligence, thoroughness and persistence with which it is carried out. The conditions should be well understood, and all the factors concerned taken into consideration, as far as possible. The underground root-stock of the weed is its food-storage organ and it must be killed outright or starved out by preventing growth of the leaves, which manufacture the food for the plant. The methods of eradication fall naturally into two classes according to the occurrence and abundance of the weed, whether in small, scattered patches or abundant over large areas.

Treatments for Small Patches.—In cases where the patches are comparatively small, any one of three methods may be used. Each of these methods will be effective, if thoroughly and persistently carried out.

First.—Keep the thistles thoroughly cut with a hoe, every week or two throughout the season for a couple of years, thus preventing all growth. Sometimes one year is sufficient. This will starve out

the underground root-stock and the thistles are certain to die eventually. Two or three cuttings through the season will not do it. The hoeing must be frequent and kept up throughout the season as long as any growth shows.

Second.—Thoroughly grub out and remove all underground root-stocks with a spade. This is especially applicable where only a few thistles not too deeply rooted occur in a place and where, also, the soil is not too hard. One operation, thoroughly done, is usually sufficient. Watch should be kept for stragglers, however, which should be treated in a similar way.



Fig. 3. Canada thistle showing recovery after being cut with the binder. The great growth of leaves stores up abundant food in the underground root-stock in the form of starch. This should be prevented and the root-stock starved
(Dotted line shows groundline)

Third.—Chemicals, in bulk may be applied. During the autumn of 1909 an experiment was undertaken by the writer to compare certain chemicals for this purpose. The chemicals used were: common salt, crude carbolic acid, Merck's formal carbolic disinfectant, coal tar creosote, sulphuric acid, and crude oil. Without going into the details of the experiment at this time, it may be said that the salt and crude carbolic acid were found superior to the other chemicals, and of these two the treatment with salt was in some ways to be preferred. It is cheap, comparatively easy of application, offers no danger from poisoning, and is to be had on every farm.

Salt has long been known to be effective for killing weeds and is here recommended without hesitation. The thistles should be cut with a sharp hoe or spade, at or just below the surface of the ground and a large handful of dry salt applied to the cut end. This will kill the shoot down to the horizontal root-stock. Later, as other shoots come up, as they will, they should be treated in the same way as soon as they appear. This treatment kept up persistently for two years is certain to kill the thistles. Most of them will be killed the first year, but the stragglers should be watched for the following year and entirely killed out.

In using crude carbolic acid, it may be mixed with four parts water and applied with a mechanic's oil can to the stems of the thistles without cutting them. The mixture must be kept well agitated in order to insure a uniform mixture. The treatment should be repeated the same as with salt. Care should be taken to guard against poisoning animals when carbolic acid is used. Any of the above methods can be used in fields of corn or other hoed crops without disturbing the crop, or on roadsides, meadows or waste places, wherever the thistles occur. The use of salt is especially applicable in pastures, in which case the licking and tramping by stock will assist in the operation.

Treatment for Large Areas.—In cases where the thistles are abundant over large areas the above methods are, of course, impracticable. In such cases one of two methods may be followed: *either* the bare fallow method, *or* fighting the thistles and raising a crop at the same time, or both of these methods in combination may be employed. The bare fallow method may sometimes be followed to advantage, especially where the thistles are very abundant and it is desired to destroy them in a short time; but the use of smother crops followed by hoed crops, which method will be taken up later, is usually to be preferred. If the fallow method is used the thistles should, of course, be kept from going to seed, by mowing just as the flowers are opening and the land plowed as soon as the new growth of thistles begins *after the crop is removed if there*

is a crop on the land, or after the thistles are mown in the summer. This first plowing should be shallow enough to avoid disturbing the underground running root-stocks. A second deeper plowing should be given late in the fall, turning up as many root-stocks as possible to be killed by the winter's frost. Subsequent thorough harrowing with a spring tooth harrow will assist in exposing the upturned root-stocks. Between the first and second plowings the land should be thoroughly worked with disc and harrow to prevent all growth. The following spring the land should be plowed again as soon as the vegetation is started, and the land is in workable condition. In fighting Canada thistles the land should never be worked when wet. This would only serve to distribute the pest by its underground root-stocks to greater areas, and in addition would be injurious to the physical properties of the soil itself. Fight Canada thistles in this way in dry weather especially. It is also well to work infested areas separately to avoid spreading the pest by distributing pieces of the root-stock to clean parts of the field.

After the first plowing in the spring, it must be decided whether the bare fallow is to be continued through the season or corn or some other hoed crop is to be raised, or if a smother crop shall be used.

If the thistles are very abundant and seem very vigorous the bare fallow may be again advisable especially on limited areas, in which case the land should be plowed about four times through the season. The first three plowings should be shallow, the last one deep, and the disc and harrow used liberally between times to prevent all growth, especially of the thistles. This treatment should be kept up until late in the fall or rye may be sown and used for pasture, followed the next spring by thorough preparation for corn or other hoed crop. Such crop should be kept perfectly clean until late in the season and the few remaining thistles removed by hand, as previously recommended for such cases.

In places where the thistles are less abundant and not so vigorous after the treatment of the preceding autumn and fall, and early spring, the corn or other hoed crop may be put on at once, and carefully tended to prevent all growth. The Tower cultivator, if kept sharp, may be used to advantage in fighting Canada thistles in corn. The hoe should be frequently used where the cultivator misses the thistles. Instead of corn, smother crops, such as a heavy sowing of millet, buckwheat, cowpeas, or oats and field peas may be used to good advantage for a year, in which case the land should be plowed and worked as soon as the crop is removed, and followed the same season by millet, rape or rye and again by corn or other hoed

crop the following year, when any scattering thistles may be removed by hand.

The bare fallow method may be employed together with the smother-crop method. That is, bare fallow, thoroughly worked, the first part of the season, followed later by a smother-crop, such as millet or rape, and these followed by rye in the fall and by corn or other hoed crop the following year.

The use of chemical sprays for fighting Canada thistles has been found more or less successful, but needs further investigations before definite recommendations can be made.

While there is no easy method of eradicating Canada thistle, it is important to fight it in every way possible, especially to keep it from spreading, and to exterminate it where it occurs in fields. Along roadsides, railroad right-of-ways and waste places where it occurs, it should always be kept closely cut, and eventually killed out entirely.

In general, thrifty people are anxious to destroy Canada thistle as soon as they know how to proceed. With this as with fighting any other public nuisance there should be the greatest cooperation. It is a very great disadvantage to one who is fighting Canada thistle in every way possible, if there are infested lands near by, the owners of which are entirely inactive in regard to the eradication of this pest. There are effective laws on the statute books of Indiana to assist in such cases and they might well be made use of in many instances. The laws fix a penalty for permitting Canada thistle to grow, unobstructed, as well as for selling or exchanging grain known to contain seeds of the weed. The laws also provide means for entering the premises of others to eradicate the pest in case the person or persons concerned can not be made to fight the weed. This law further provides that the expense of such operations may be entered as a special tax against such land.

INDIANA LAWS PERTAINING TO CANADA THISTLE

PENAL MEASURES: ACTS 1905, INDIANA (64TH SESSION), pp. 738-739.

Sec. 627. CANADA THISTLES—ALLOWING TO GROW.—Any person who shall knowingly allow Canada thistle or thistles to grow and mature, or shall allow any Canada thistle or thistles to grow until they or any of them become of the length of six (6) inches, measuring from the surface of the soil to the end or the tip of the stem above the surface of the ground, upon his, her or their land, or upon any land which they shall occupy or have under their charge and

control; and every supervisor of roads or other officer, having charge of or control over highways, who shall knowingly allow any Canada thistle or thistles to grow or mature, or grow to the length of six (6) inches as above defined, in any public highway, street or alley over which such supervisor or officer has supervision; and every section boss, roadmaster or other officer of any railroad having charge of or control over such railroad property, who shall knowingly allow Canada thistle[s] or any Canada thistle to grow and mature, or to grow to the length of six (6) inches as above defined, on any lands held, owned or used by said company or by any person operating such railroad, depot or station grounds, as right of way or otherwise, for the portion of said railroad over which such section boss, roadmaster or other officer has supervision, shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined, for the first offense, in any sum not more than one ($1) dollar, and for each subsequent offense in any sum not more than ten ($10) dollars.

Sec. 627a. Complaint to Supervisor.—If any resident in any township of this state shall make complaint to any road supervisor in the township in which such resident may live that any owner or occupant of land (as described in section 627 of this act), in the said road supervisor's district, is allowing Canada thistle to grow (as defined in section 627 of this act), it shall be the duty of said road supervisor to notify the said owner or occupant of said land to within five (5) days cut the said thistles off below the surface of the ground. Any owner or occupant of land, after having been notified as aforesaid, who shall fail to perform the duties required of him by the preceding section and by section 627a of this act, shall be guilty of the offense described in section 627 of this act and liable to the penalties provided therefor.

Sec. 627b. Failure of Supervisor, Township Trustee or Mayor.—Any supervisor who shall fail to perform the duties required of him by this act shall be guilty of the offense described in section 627 of this act and liable to the penalties therefor: *Provided,* That in case any road supervisor or other officer having charge of any public highway, road, or street (as described in section 627 of this act), it shall be the duty of the township trustee in case the offense shall be committed outside of the limits of any incorporated town or city of this state; or in case it shall be inside the limits of any incorporated town or city, it shall be the duty of the mayor or president of the board of trustees of such town or city to perform the duties required of the road supervisor in section 627a of this act.

Sec. 627c. Convictions.—Fee of Supervisor.—For every conviction under this act brought about by a road supervisor or other officer whose duty it shall be to enforce the provisions hereof, he shall receive five ($5) dollars, to be taxed as other costs in the case.

Sec. 628. Grain Containing Thistles.—Whoever knowingly sells or barters any seed or any grain of any kind whatever, containing Canada thistle's seed, shall, on conviction, be fined not less than twenty dollars or more than two hundred dollars.

Remedial Measures: Acts 1907, Indiana (65th Session), pp. 50-52. Chapter 32.

An Act concerning canada thistle and thistles, the cutting of the same, providing for expense of cutting, tax, and method of collection.

[H. 202. Approved February 21, 1907.]

Sec. 1. Canada Thistles—Supervisor—Duties.—Be it enacted by the general assembly of the State of Indiana, That it shall be the duty of road supervisors in this state, in addition to their other duties, when any person has made complaint of them, that there is growing on the premises of any land owner or resident tenant within their districts, Canada thistles to the length of six inches, measuring from the surface of the soil to the end or tip of the stem above the surface of the ground, to enter upon any such premises without anywise being a trespasser, and if they ascertain such report to be true, they shall notify the owner, occupant, tenant or agent of said land to within five days cut the said Canada thistles off below the surface of the ground, and if said owner, occupant, tenant or agent can not be found, then by posting a notice reciting that such Canada thistles are growing in such manner on such premises, describing the same, and demanding that they be cut in such manner as herein provided, in the township where such land or premises are located, and in a public place therein, for five days, and at the expiration of such time, if said Canada thistles have not been removed as provided, then in that event, such road supervisors or supervisor shall report the matter to the trustees of the township wherein such land or premises are located, and make a certified statement in writing of any and all action taken, and that said Canada thistles have not been cut off as demanded in the said notification or notice.

Sec. 2. Township Trustees—Duties.—It is hereby made the duty of the township trustees of this state, immediately upon receiv-

ing the road supervisor's report and statement as mentioned in the preceding section, to cause such Canada thistles to be cut off as herein and heretofore provided in this act, and existing laws on the subject. Such trustee or trustees shall assign the work of cutting and removal of such thistles to the road supervisor making report, and if he decline then by employing one resident of the township to do such work, and the trustee, supervisor or person employed for the purpose, may enter upon the lands, premises and property of another to perform such work and labor, and in the discharge of said duty shall in nowise be deemed or held as a trespasser.

Sec. 3. Compensation—Lien on Land.—Township trustees, with the advice of the advisory board, and under such rules as they may prescribe, are hereby authorized to pay for such work and labor performed in the cutting of thistles under the provisions of this act, the sum of twenty cents an hour, for the time actually employed in the said work. When said work has been performed, the person doing the same shall file his itemized bill for such work in the office of the trustee of the proper township, and when the same has been approved or allowed, the trustee of the township shall certify such cost or expense of such work with a description of the farm or premises on which said labor was performed to the auditor of the county in which said lands, property or premises are situated, and upon the filing of such trustee's certificate in the office of the auditor, such sums or sum for labor performed, shall be a lien against the lands, property or premises named or described in such certificates, as the lands on which such Canada thistles are cut.

Sec. 4. County Auditor—Duties.—That county auditors, upon receiving and filing such trustees' certificates as named in this act, shall immediately place said amounts on the tax duplicate of the county as a special tax against such lands, property or premises, and such special tax shall be due at the next taxpaying time, and shall be collected for the proper township or townships, the same as other state, county or township taxes are collected, including penalties, forfeitures, and sales.

Sec. 5. Towns—Act Applies.—This act shall also apply to towns in this state, and the duties required to be performed by road supervisor, shall be performed by the marshal or street commissioner in said towns, and the duties required to be performed by township trustees shall be performed by the board of trustees of said town.

SUMMARY OF METHODS FOR ERADICATION OF CANADA THISTLE

For Small Patches.—*First*: cut down to the ground repeatedly with hoe, or other instrument, as often as any growth above the ground is evident, or *second*: carefully dig out and destroy entire root system, or *third*: apply salt to cut ends of thistles or apply to stems without cutting, crude carbolic acid thoroughly mixed with four parts of water. Salt is usually to be preferred.

For Large Areas.—Bare fallow method: plow shallow at intervals of about six or seven weeks, thoroughly working the land with disc and harrow, especially during dry weather, between plowings, preventing all growth until late in the fall. Follow with well kept, hoed crop the next year, keeping a sharp watch for thistles, destroying stragglers by individual attention.

Cropping Method.—Smother crops: millet, buckwheat, cow peas, or oats and field peas; second smother crop as soon as first is removed, such as thickly sown rape or rye for pasturing. Plow in following spring and prepare well for corn or other hoed crop to be kept thoroughly clean.

Bare Fallow Together with Cropping.—Bare fallow and work thoroughly early in the season, then sow millet thickly, follow with rye in fall and pasture. Plow under the rye the following spring and plant corn, or other hoed crop, and give individual attention to scattered thistles that remain.

The last two methods are usually to be preferred.

PURDUE UNIVERSITY
Agricultural Experiment Station

Circular No. 33

LaFayette, Ind., February, 1912

LIMING THE SOIL

John B. Abbott
Department of Soils and Crops

Producers of lime and ground limestone are practically unanimous in saying that the use of these materials for agricultural purposes is increasing very rapidly. One reply to a circular letter of inquiry which was sent to producers stated that the business of the past year exceeded the combined totals of the three years preceding and every other reply, except one, noted a marked increase in consumption, particularly within the past year. This rapid increase in the use of agricultural lime is undoubtedly quite largely due to the awakening of interest in alfalfa culture, and the general acceptance of the teaching that nearly all land in Indiana, except limestone land showing outcrops of stone, must be limed before this valuable crop can be most successfully grown.

Many of the inquiries received by the Experiment Station relative to the use of lime on the soil are so vague in character as to lead us to believe that in many cases lime is being used without a clear understanding of its effect on the soil, or of when it should be used and when it should not. In view of the sometimes extravagant claims for its good effect, and the equally extravagant warnings as to the dangers in its use, it seems probable that some farmers are using lime where it is totally unnecessary and sustaining a financial loss thereby, while others fear to use it where it is really needed, thereby failing to reap a possible profit. For these reasons this circular of general information on the lime question is offered at this time.

THE CHEMISTRY OF LIME COMPOUNDS

There are two classes of chemical compounds, acids and bases, which have the power to destroy or neutralize the characteristic properties of each other. Lime is a basic or alkaline material, and is applied to the soil primarily for the sake of neutralizing harmful

acids. Lime is used in preference to other basic materials which might perform the same function because it is the natural basic material of all soils, and is efficient and cheap. The compounds of lime which are used for this purpose are the carbonate (limestone,—or marl, which is a soft friable form), the hydrate (water-slaked lime), the oxid (quick lime), and an indefinite mixture of hydrate and carbonate, largely the latter (air-slaked lime and lime kiln waste). Lime existing in neutral compounds, that is, compounds in which it is already combined with some strong acid, has no power to neutralize more acid. Phosphate of lime (raw rock phosphate), and sulphate of lime (land plaster or gypsum), are compounds of this class, and hence are of no appreciable value in correcting soil acidity. The small amount of carbonate of lime generally existing as an impurity in rock phosphate is effective in correcting soil acidity, but it would not be good practice to buy it for that purpose at rock phosphate prices.

When 100 pounds of pure limestone (calcium carbonate) are burned, 44 pounds of carbon dioxid gas are driven off by heat, and 56 pounds of quick lime (calcium oxid) remain. In slaking with water 56 pounds of quick lime take up 18 pounds of water and become 74 pounds of water-slaked or hydrated lime (calcium hydrate). When water-slaked lime is left exposed to the air it gradually air slakes, which is a process of absorption of carbon dioxid from the air, and in time reverts to the original compound, calcium carbonate. It takes a long time for air slaking to become complete, and air-slaked lime, as the term is generally understood, has neither regained all of its original weight nor lost all of the chemical properties of the water-slaked lime.

Burning, water slaking, and air slaking, do not change the amount of calcium present in the original 100 pounds of stone, or the power to neutralize acids, so it follows that 100 pounds of pure limestone, 56 pounds of quick lime, 74 pounds of water-slaked lime, and 90 to 100 pounds of air-slaked lime are equal, so far as acid neutralizing power is concerned. They are not equal, however, in their effect on the soil as certain of their chemical properties differ materially.

Ground limestone is inactive except in the presence of acids and will not attack or corrode the skin or leather articles with which it may come in contact. It will not dissolve the organic matter in the soil or expel ammonia from ammoniates. Marl is similar in properties to ground limestone.

Air-slaked lime differs in properties from ground limestone only as it is in a state of finer division and may contain more or less hydrated or water-slaked lime.

Water-slaked lime is somewhat corrosive, attacking the skin, and shoes, harnesses, etc., with which it may come in contact, dis-

solving organic matter in the soil and expelling ammonia from ammoniates.

Quick lime is caustic, attacking the skin, and shoes, harnesses, etc., quite violently, dissolving organic matter in the soil and expelling ammonia from ammoniates. It is probably more active than the other forms in liberating mineral plant food from the soil.

The difference in solubility of these compounds in the soil water is largely dependent upon the fineness of division, as all forms rapidly revert to carbonate in the soil, and are then on an even basis. It is not practicable to pulverize limestone to so fine a state of division as the burned forms, and for this reason ground limestone is somewhat less immediately effective per pound of acid neutralizing power, but since a considerable excess is generally applied this point is of little practical importance. In some of our experiments ground limestone has been found to correct soil acidity so thoroughly within two months after application that clover would grow where before it had failed.

Ground limestone and air-slaked lime are less destructive in their action on the soil than burned or water-slaked lime and for that reason are to be preferred.

There has been more or less prejudice against the use for agricultural purposes, of limestone containing large amounts of magnesium carbonate but there seems to be no conclusive evidence that it is well founded. Magnesian lime has been used in England for centuries with good results, and is giving good results in this country. There is no apparent good reason for discrimination against it on chemical grounds, as a given weight of magnesium carbonate will neutralize somewhat more acid than the same weight of calcium carbonate. Magnesium and calcium are similar in action on the soil and are equally necessary as plant foods. There is evidence indicating that it might not be best to use magnesium carbonate alone in excessive amounts, but in the proportion in which it exists in our Indiana limestones there is no apparent objection to using it.

LIME AN ESSENTIAL SOIL CONSTITUENT

Lime, considered as the source of the element calcium, is one of the ten absolutely essential plant foods. As such it is required in only small amounts, and it is probable that nearly all soils contain enough to satisfy the direct needs of the plant.

Lime, considered as a basic material capable of neutralizing acids, has other and not less important functions to perform. Acid or sour soils do not contain enough to perform these functions. Maintenance of the supply of nitrogen in the soil is largely dependent upon the fixation of atmospheric nitrogen by the nodule forming bacteria of legumes, and in acid soils these bacteria do not thrive. Clover on such soils fails to develop nodules and if it grows at all,

as it sometimes will when heavily manured, even on quite acid soil, it gets its nitrogen from the soil just as other crops do. In such cases, of course, the soil is not materially enriched by the growth of clover, and may even be impoverished. Nitrogenous organic matter, such as clover and manure, must go through a process of bacterial decomposition before it becomes soluble and available to plants, and in the absence of sufficient lime to neutralize all acids as fast as they are formed, this process is seriously interfered with, and other fermentations of a destructive nature are liable to take its place. Between such unfavorable fermentations on the one hand and poor success with legumes on the other, it is apt to prove a very difficult matter to keep up the nitrogen supply of acid soils.

Soils yield up their phosphoric acid and potash more readily in the presence of adequate supplies of lime, and the assimilation of phosphoric acid seems to be seriously hindered by a deficiency.

A few species of plants, such as dewberries (Rubus Canadensis) and red sorrel (Rumex Acetosella) seem to thrive just as well on acid soils, but our general farm crops do not. Touching upon this point and referring to carbonate of lime, Prof. Hilgard says: "Its presence exerts a dominant and beneficial influence in many respects, as is readily apparent from the prompt change in vegetation whenever it is introduced into soils deficient in it." This point finds forcible confirmation in our Wanatah experimental field on a very sour soil in LaPorte county, where we have been able to replace wild flax, dewberries, red sorrel, pine weed and similar worthless vegetation with clover, corn, oats, wheat, timothy, cow peas, soy beans, potatoes, and in fact any crop which we have seen fit to try, by a liberal use of ground limestone. Without lime, these crops have persistently failed. This, of course, is an extreme case, but for that reason it serves the better to illustrate the principle.

HOW LIMING AFFECTS THE SOIL

Liming has two principal effects on the soil, both operative principally through the correction of soil acidity and control of bacterial activity. The first principal effect, the promotion of the growth of legumes, results in building up the nitrogen supply and general fertility of the soil, and is in all respects a good and desirable thing. It is to be especially noted, however, that this building up of the fertility of the soil is accomplished principally through the legume crops, and that if they are neglected the principal end and aim of liming to improve the soil is defeated. The mere application of lime cannot materially enrich the soil.

So far as this first principal effect of liming is concerned, tangible results in the form of bigger yields are not immediate except in the case of the leguminous crops, which develop more nodules, fix more atmospheric nitrogen, and make correspondingly larger growth.

The benefit which the grain crops derive from the growth of larger leguminous crops evidently cannot begin to show until at least one leguminous crop has been grown subsequent to the application of lime. In other words, the constructive, soil enriching effect of lime is not generally noticeable until the second or third year after application.

The promotion of the growth of legumes is the one effect which, above all others, justifies the use of lime.

The second principal effect on the soil is destructive and exhaustive rather than constructive and enriching, and may become



Fig. 1. Effect of limestone on soy beans on acid marsh soil in Laporte county

extremely bad if carried to excess. It is a process of increasing the availability of all the plant foods in the soil, but more especially the nitrogen, so that they may be the more quickly and thoroughly used up. The results in this direction are immediate and affect all crops but are not lasting, and the tendency is toward more rapid soil exhaustion, not only due to the production of larger yields, but in a larger degree to leaching of nitrogen, and too rapid combustion of organic matter. So long as the stimulating effect of lime does not result in rendering available more plant food than the crop can economically use, it is perhaps justifiable, for the plant food is in the soil to be used, but as soon as it goes beyond that point and

causes an excessive amount to become available and subject to loss in the drainage water it becomes pernicious, for the plant food is not in the soil to be wasted.

The production of larger crops by any means except direct fertilization, no matter whether it be by superior tillage, by the growth of more prolific varieties, or by the use of lime, necessitates the use of larger amounts of manure, clover and fertilizer, to maintain the balance of income and outgo of plant food, and in this fact lies the truth of the old saying, "Lime and lime without manure, makes both farm and farmer poor." Lime is not a fertilizer in the commonly accepted sense, as it contains neither nitrogen, phosphoric acid nor potash, so it naturally follows that dependence upon lime alone must soon result in a shortage of one or more of these elements.

There are extremely few cases in which it is good practice to use lime except in connection with other treatment.

It should be clearly understood that the two principal effects of lime above discussed are operative at the same time, and that the question of which shall become dominant is a matter of soil management. The use of the milder forms, ground limestone and air-slaked lime, in connection with plenty of legume crops or manure, will cause the constructive effect to be dominant, and the destructive effect will be so slight as to be practically negligible. The use of the more caustic forms, quick lime and hydrated lime, particularly if legumes and manure are neglected, will cause the destructive effect to become dominant, and even with the use of plenty of legumes and manure it seems that burned lime is more destructive than the milder forms.

At the Pennsylvania Experiment Station, at the end of 20 years, the soil of plats which had been treated with two tons per acre of ground limestone once in two years contained in the surface nine inches 375 pounds of nitrogen and 4.7 tons of humus more than the soil of adjoining plats which had been treated with two tons per acre of burned lime (slaked before being applied) once in four years, notwithstanding the fact that the limestone plats had produced a greater total yield of all crops grown in the meantime. Similar results showing the superiority of carbonate of lime over burned lime are reported by the Maryland Experiment Station.

The utter absurdity of the idea that the use of a ton or two of limestone per acre may seriously injure the soil becomes at once apparent when it is recalled that limestone soils are world famous for their fertility and have been for generations. The real trouble with some of the soils in our eastern states which are said to have been injured by the use of lime is lack of organic matter and nitrogen as much as anything else, and exactly the same conditions prevail all over the southern part of Indiana *where practically no lime*

has been used. This lack of organic matter and nitrogen is traceable, in both cases, mainly to poor rotations or none at all, poor care of manure or the production of an insufficient amount, and burning or selling straw and stover, and the final results seem to have been largely independent of the use or non-use of lime. This statement must not be taken to mean that lime never exerts an unfavorable effect, but rather that a good part of the unfavorable effect generally attributed to it is in reality due to poor methods of farming. Lime is simply made a convenient excuse, a scape-goat, just as is commercial fertilizer in certain sections, and with no more reason.

Among the minor effects of lime may be mentioned its influence upon the type of vegetation, the flocculation of clay soils, and the neutralization of certain toxic or poisonous materials. This latter effect is particularly evident in the case of certain sour marsh soils.

DO INDIANA SOILS NEED LIMING?

Lime has been applied either with fertilizer or alone in 46 of our cooperative corn and wheat fertilization experiments. In 18 experiments, or 39.1 per cent. of the entire number, it increased the yield enough to render its use apparently profitable, while in the remainder of the experiments the results were inconclusive. In a few cases the use of hydrated lime at the time of seeding apparently decreased the yield. It should be borne in mind that all but seven of these experiments were single year experiments and that any increase due to the use of lime must have been due to its effect in increasing the availability of the plant food in the soil, or possibly in certain cases to some of its minor effects, such as the neutralization of toxic materials. The effect of lime in promoting the growth of legumes, which in most cases is the really important thing, is not shown by these tests. It is quite probable that clover would be benefited in certain cases in which the grain crops showed no increase, and that it would not be benefited at all in certain other cases in which the grain crops did show an increase. A thorough understanding of the two principal effects of lime, as previously discussed, will render this point clear.

Of the 150 miscellaneous soil samples which have been examined in this laboratory within the past year, 10.7 per cent. were alkaline, 58.6 per cent. neutral or but faintly acid, and 30.7 per cent. were unmistakably acid. The number of soils examined is not sufficient to permit grouping them by soil types or soil area, and in the absence of a detailed soil survey of the state, and of adequate field experiments on each soil type, it is not possible to state definitely just how much of the soil of Indiana needs lime, or where the need of lime is most general.

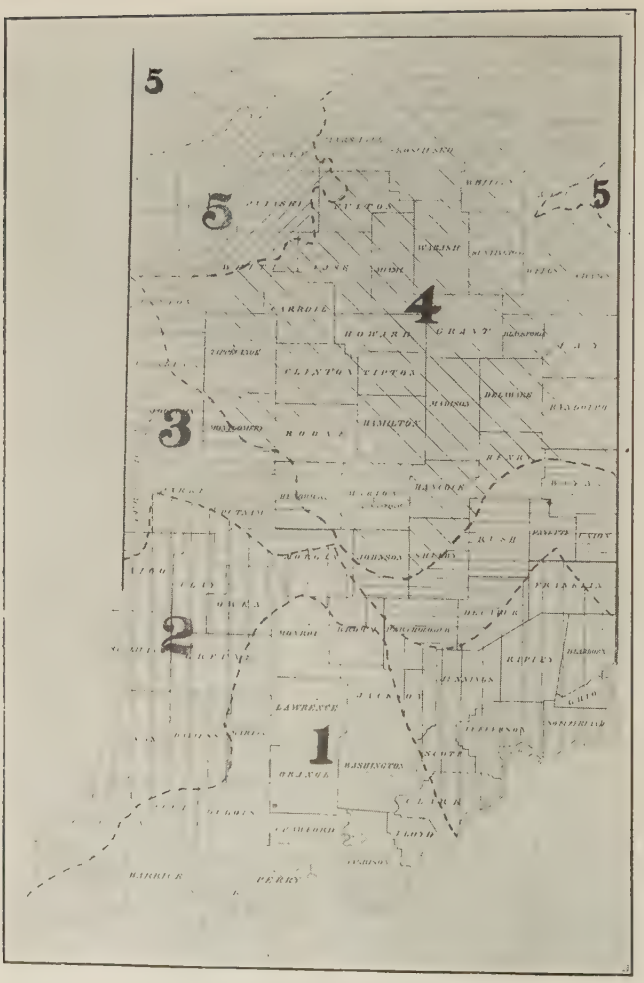


Fig. 2. General soil map of Indiana by S. D. Conner, chiefly after Frank Leverett's glacial maps

Section 1. Unglaciated
" 2. Lower Illinoisan glaciation
" 3. Early Wisconsin glaciation
" 4. Late Wisconsin glaciation
" 5. Marsh areas

The Illinois Experiment Station has been able to go into the matter of the lime requirements of the soil much more thoroughly than has thus far been possible at this station and has collected a large amount of data which appears to be equally applicable to soils of the same glaciation and same general character in Indiana. It appears from the work of the Illinois Station that the yellow or red silt loam hill land soil of the unglaciated area, which in Indiana includes the greater part of section 1, as shown on the accompanying map, is for the most part practically neutral or acid.

On the Vienna soil experiment field, located in Johnson county, Illinois "the effect of the ground limestone, applied five years before, was to increase the crop yields in 1907 by 12.5 bushels of corn, by 6.9 bushels of wheat, and by 1.11 tons of clover hay. The quality of the crops was also improved, especially of the clover which was half weeds on plots 1 and 2 without limestone but good, clean hay on plots 3, 4, and 5. (with limestone)

At 35 cents a bushel for corn, 70 cents for wheat and $6.00 a ton for air-dry clover hay, the value of the increase produced by the ground limestone amounts to $15.87 for the three crops."

This may not necessarily mean that the similar types of soil which occur in the unglaciated area in Indiana are in exactly the same condition, but when taken in conjunction with the typical sour land vegetation and the poor success with clover, so frequently noted in this region, it is at least suggestive. It seems probable that there is a great deal of soil in this region which would be benefited by liming, though, of course, where the glacial drift and loessial deposit have been entirely eroded, and the limestone formation exposed, the soil does not need lime.

The Illinois Station finds the gray silt loams on tight clay subsoil of the lower Illinoisan glaciation, which in Indiana includes the greater part of section 2, as shown on the accompanying map, to be uniformly poorly supplied with lime, and in many cases very acid.

On the Odin soil experiment field in Marion county, Illinois, "as an average of the four years 1904, 1905, 1906, and 1907, wheat grown in this rotation" (clover, corn, cow peas, wheat) "has produced 11.5 bushels per acre with no special soil treatment, all crops having been removed.

Where one cow pea crop and some catch crops (as cow peas seeded in the corn) had been plowed under during the rotation, the average yield of wheat was increased to 14 bushels.

Where lime or ground limestone had been applied and the cow peas also plowed under, the average yield of wheat has been 18.5 bushels per acre. On this set of plats, better cow pea crops and catch crops have been produced and turned under as green

manure, because the soil acidity has been corrected by the lime, *applied for the special benefit of the legume crops."* [1]

The Illinois Station reports that the silt and clay loam soils of the Wisconsin glaciations, (sections 3 and 4) which in Indiana cover most of the state except the marsh areas (section 5) north of the previously described sections, (sections 1 and 2) were originally much better supplied with lime and that they are for the most part still sweet, or at least not strongly acid. Those portions which have been most exhaustively cropped, and certain areas of yellow silt loam, have been found to respond to an application of limestone, but as a general rule lime is not as yet badly needed. It is certain, however, that the original supply is being rapidly exhausted, and that in the case of the areas less well supplied in the first place the excess supply is at present very small.

It would seem from the above statement that the silt loam soils in the northern two-thirds of Indiana are probably in very fair condition as regards lime, and such experiments and observations as we have been able to make tend to confirm this view. There are, however, quite extensive areas of sandy soil in the northern counties which are more or less acid and which show marked benefit from the use of limestone. There are also several areas of extremely acid soil in the Kankakee marsh region (the largest part of section 5) where the production of profitable crops without the application of lime in rather large amounts seems to be impossible. This latter type is a black or brown sandy or sandy loam soil, the color varying quite widely within very short distances according as there is more or less organic matter present. This soil is known locally as "dewberry land" because of the prevalence of dewberries to the exclusion of the grasses, and in its natural condition it is probably the least fertile soil in the state. So far as known at present this type does not cover more than 30 to 50 square miles. The moderately fertile sandy loams, however, are of much wider distribution.

In summarizing the situation in a few words, it may be said that the dominant soil types in about one-third of the state are initially poorly supplied with lime, and a very considerable portion of this area is actually acid at the present time. The soils predisposed to acidity in the southern part of the state (sections 1 and 2) are silt loam and loessial deposits of light color (gray, yellow and yellowish red), close texture, and low organic matter content. Those in the northern part of the state are sandy soils of open texture and low organic matter content, with the exception of the extremely acid soils in the marsh region, (section 5) which are well supplied with organic matter.

It is to be especially noted in this connection that all soils or,

[1] The italics are mine. J. B. A.

at least, nearly all soils which need lime, need other things also. In our cooperative fertilizer tests lime alone has seldom produced any marked results. The other things most commonly needed are phosphatic fertilization, organic matter and nitrogen, drainage, and aeration.



Fig. 3. Effect of limestone and acid phosphate in securing a stand of clover. Plat on left not treated

HOW TO TELL WHETHER LIMING IS NEEDED OR NOT

The behavior of crops and the vegetation growing on the land may furnish all the evidence needed. Poor success with clover which cannot be explained on the grounds of unfavorable weather, lack of plant food, or poor water holding capacity of the soil due to the exhaustion of organic matter, and the presence of red sorrel or dewberries in dense patches, are strong indications of acid soil. Failure of clover is not in itself a sufficient indication as there are a variety of causes aside from soil acidity which may bring about clover failure.

The one best way to tell whether or not the soil needs lime is to try it and see, and the place to try it is on the clover crop. A good plan is to apply ground limestone at the rate of two tons per

acre and harrow in before sowing wheat, and in the spring sow clover as usual. The clover may fail because of shortage of plant food or bad physical condition of the soil even on the limed land, so it is best to use a light application of manure in connection with the lime on a part of the limed strip. In case there is a stand of clover on both limed and unlimed land, the two areas should be harvested and weighed separately to determine whether or not the lime has made sufficient gain to justify its use.

Acids turn blue litmus paper red, and this test has been recommended for soil acidity, but we do not regard it as entirely satisfactory. However, for the information of those who may wish to try it, we give the following directions: place a strip of blue litmus paper between two wider strips of filter paper, break open a moist clod, place one end of the strips of paper in the fracture, and press the clod together firmly. In about ten minutes remove the litmus paper and pin it up to dry by the end which was left out of the soil. A change to pink or red which lasts after the paper is dry indicates acid. Do not handle the end of the paper used for testing or allow anything to touch it. Repeat the test with different samples and if doubtful, test the subsoil which is generally more acid than the surface soil. Blue litmus paper and filter paper can be bought at any drug store.

LIME FOR ALFALFA

The Experiment Station has been conducting cooperative experiments on liming the soil for alfalfa for the past six years. About 50 successful experiments representing as many different localities have been reported and tabulated. In about 60 per cent. of these experiments lime failed to increase the yield, but in the other 40 per cent. made an average increase of a little over 1200 pounds of cured hay per acre the first year after seeding. These results do not mean that lime will help alfalfa 40 per cent. of the time, irrespective of locality, but rather that 40 per cent. of our experiments, located by chance, happened to be on soils requiring more lime for the best success with alfalfa.

In view of the numerous cases in which lime has failed to increase the yield of alfalfa materially, it would not seem advisable to go to the expense of applying limestone to a large acreage without definite knowledge that it is needed, nor on the other hand would it seem advisable to go to the considerable expense of seeding a large acreage without assurance that the soil contains enough lime so that alfalfa will succeed. The safe practice to follow is to start with an experimental field of only a few acres, and lime part of it. Such an experiment may be the means of preventing a failure and loss of seed, or an unnecessary expense for lime.

Alfalfa seems to be more sensitive to a shortage of lime than any of the common crops, clover not excepted, and to respond more profitably to a considerable excess; hence, heavy applications of ground limestone, ranging from two to eight tons per acre, are advised. In the case of the larger applications a coarser grade of ground limestone may be used, thus reducing the cost per ton somewhat.

APPLICATION OF LIME

Soils which are only faintly acid respond fairly satisfactorily to a light application of lime, but the same causes which operated to use up the original supply will operate to use up that which is applied, and in a very few years the application will have to be repeated. The labor cost of making a heavy application is not very much greater than that of making a light application, so on the



Fig. 4. A convenient method of spreading limestone

ground of economy it is undoubtedly wiser to make a relatively heavy application and not have to repeat it so soon. Two tons per acre of ground limestone is ordinarily sufficient, though some extreme cases may require more.

Lime can be most economically applied with one of the special lime spreaders, of which there are a number on the market, or with a home made spreader which can be made from a pair of old mower wheels and rough lumber with a little help from the blacksmith. It can also be applied with the manure spreader, but this practice is not to be recommended as the spreader is too heavy to haul and the lime is hard on the gearing. Spreading it by hand is a disagreeable and expensive job, and is not to be thought of except on a small scale.

It makes little difference at what time of year lime is applied, but it should be applied after rather than before plowing so that it

will not be buried too deeply. Lime should not be mixed with either fertilizer or manure, as it may decrease the availability of phosphates or cause a loss of nitrogen, but they may be worked into the soil separately without danger of loss. As a matter of economy in handling it, lime should be applied during a slack season and when the roads are good.

PURCHASING AGRICULTURAL LIME

Lime is purchased and applied to the soil primarily for the purpose of correcting soil acidity, and if considered on that basis alone, the relative value of the various kinds must be inversely proportional to the amounts required to neutralize a given weight of acid. In other words, the price of limestone should be less than the price of quick lime in the ratio of 56 to 100: the price of air-slaked lime less in the ratio of 56 to 95; and the price of water-slaked lime less in the ratio of 56 to 74. Upon such a basis, quick lime at $5.00 per ton, water-slaked lime at $3.78 per ton, air-slaked lime at $2.94 per ton and ground limestone at $2.80 per ton are equally good bargains, assuming them to be equally pure. As a matter of fact they will not be found equally pure and the rather frequent presence of large amounts of silica, clay, and other insoluble matter make it unsafe to buy any kind of lime except on the basis of a chemical analysis.

There are several other factors besides acid neutralizing power which influence the practical value of agricultural lime, and which must be considered along with price per pound of acid neutralizing power in deciding which is the most economical purchase in any particular case. To be effective, lime must be in the form of a powder, or at least very finely divided, so that it will readily go into solution in the soil water, and thus permeate the soil and neutralize all acids; hence, other things being equal, the finer the powder the more valuable the product. A material, such as crusher screenings, which contains a little dust and a lot of small pieces of stone, has to be used in such large amounts in order to obtain a sufficient amount of fine material that the labor cost of handling and application is rather excessive, and makes its use of doubtful advisability, particularly if it has to be shipped or hauled any great distance.

Freight and hauling are two of the principal items of expense in liming, and in the case of long hauls they can be materially reduced by using the more concentrated forms, quick lime and slaked lime, but the saving is partly or wholly offset by the generally greater cost of these materials per pound of acid neutralizing power, their more destructive action on the soil and the fact that they are more disagreeable to handle.

The purity of the product is an important point to be considered. There are grades of ground limestone on the market at the present time running all the way from 80 per cent. pure up to 95 per cent. pure and the presence of 15 pounds of impurities in every 100 pounds of stone lowers the quality so seriously that the price, too, should be correspondingly lower.

Manufacturers should be required to guarantee the minimum percentage purity of all forms of agricultural lime and in the case of ground limestone and crusher screenings, the fineness to which it is ground as well. Impurities do no particular harm except to lower the strength of the product so there is no objection to using a lime of low purity provided the price is right. There is some difference of opinion as to how finely it is most economical to grind limestone, but judging from the best products on the market at the present time it is perfectly feasible to grind the stone finely enough so that it will all pass through a sieve with 10 meshes to the linear inch, half of it through a sieve with 40 meshes to the inch and one-fourth of it through a sieve with 100 meshes to the inch and still sell it at a reasonable price.

We would suggest to the trade and to consumers that, for the sake of convenience and uniformity, the following form of guarantee be adopted.

Purity.—This (..... Fill in name of product) is guaranteed to be.....per cent. as powerful as chemically pure calcium oxid in neutralizing acids.

Fineness.—This (..... Fill in name of product) is guaranteed to pass through a standard sieve with .. meshes to the linear inch, .. per cent. to pass a standard sieve with 40 meshes to the linear inch and .. per cent. to pass a standard sieve with 100 meshes to the linear inch.

Further guarantees as to the amounts of calcium oxid and magnesium oxid may be required at the option of the consumer, but are not so essential.

In case lime is bought under guarantee, subject to analysis, the Experiment Station will determine the acid neutralizing power and state of fineness free of charge so far as time permits, upon request of the consumer and receipt of the sample, charges prepaid. It should be understood, however, that this is done merely as a matter of accommodation, and that no responsibility can be assumed beyond that of making correct analyses of the samples received.

SOME MANUFACTURERS OF AGRICULTURAL LIME[1]

Firm Name and Address	Shipping Point	Product
A. & C. Stone & Lime Co., 17 N. Penn. St., Indianapolis, Ind.	Greencastle, Ind.	Screenings Ground limestone
Bedford-Linton Crushed Stone Co., Williams, Ind.	Williams, Ind.	Ground limestone
Casparis Stone Co., Kenneth, Ind.	Kenneth, Ind.	Ground limestone
Louisville Cement Co., 237 West Main St., Louisville, Ky.	Milltown, Ind.	Quicklime Ground quicklime Hydrated lime Ground limestone
Lehigh Stone Co., Kankakee, Ill.	Lehigh, Ill. Kankakee, Ill.	Ground limestone
Mitchell Lime Co., People's Gas Bldg., Chicago, Ill.	Mitchell, Ind.	Ground limestone
Muncie Stone & Lime Co., 1701 E. Washington St., Muncie, Ind.	Muncie, Ind.	Ground limestone
Ohio & Western Lime Co., Citizens' State Bank Bldg., Huntington, Ind.	Huntington, Ind.	Ground quicklime
Ohio & Indiana Stone Co., 318 Traction Terminal Bldg., Indianapolis, Ind.	Greencastle, Ind. Ingalls, Ind.	Ground limestone Screenings
Stone Products Co., Bedford, Ind.	Bedford, Ind.	Ground limestone
Spencer Stone Co., American Central Life Bldg., Indianapolis, Ind.	Spencer, Ind.	Ground limestone

SOME MANUFACTURERS OF LIME DISTRIBUTERS[1]

The American Seeding Machine Co., Springfield, Ohio.
The Peoria Drill & Seeder Co., Peoria, Ill.
The Nonpareil Manufacturing Co., Cochranton, Pa.
The Empire Drill Co., Shortsville, N. Y.

[1]These lists include all firms known to the Station, but are doubtless incomplete

PURDUE UNIVERSITY
Agricultural Experiment Station

Circular No. 34

LaFayette, Ind., March, 1912

ORCHARD SPRAY CALENDAR

M. W. Richards
Department of Horticulture

The practice of spraying has developed so rapidly in recent years that the grower has had hard work to keep pace with it. New remedies have been discovered and old ones put to new uses until many fruit growers are confused in regard to the materials to use in the orchard and the time to apply them.

This circular has been prepared to meet the needs of such orchard owners. It presents a complete spraying schedule for orchard fruits with recommended formulae for preparing the materials and the approximate time of application for those which are most important and most generally used.

REMEDIES

Bordeaux Mixture

Formula— 4 pounds copper sulphate (blue stone)
6 pounds lime (unslaked stone lime or hydrated lime)
50 gallons water

Bordeaux mixture has long been the standard fungicide used in orchard spraying. It is made by suspending four pounds of copper sulphate in a gunny sack in about 15 gallons of water. The copper sulphate dissolves and a clear blue solution is formed. Six pounds of lime are slaked and diluted to about 15 gallons. The dilute solution of copper sulphate and the milk of lime are then poured through a strainer simultaneously into the spray barrel. The resultant mixture is diluted to 50 gallons and is known as Bordeaux. This is a very finely divided solid and is in suspension in the liquid. It must, therefore, be kept thoroughly agitated during application. In making large quantities of Bordeaux it is advisable to mix the copper sulphate and lime in stock solutions. This is done by weighing out a definite amount of each substance and then diluting them to a known volume as for example, 100 pounds of copper sulphate dissolved and made up to 50 gallons of water, and 100 pounds of

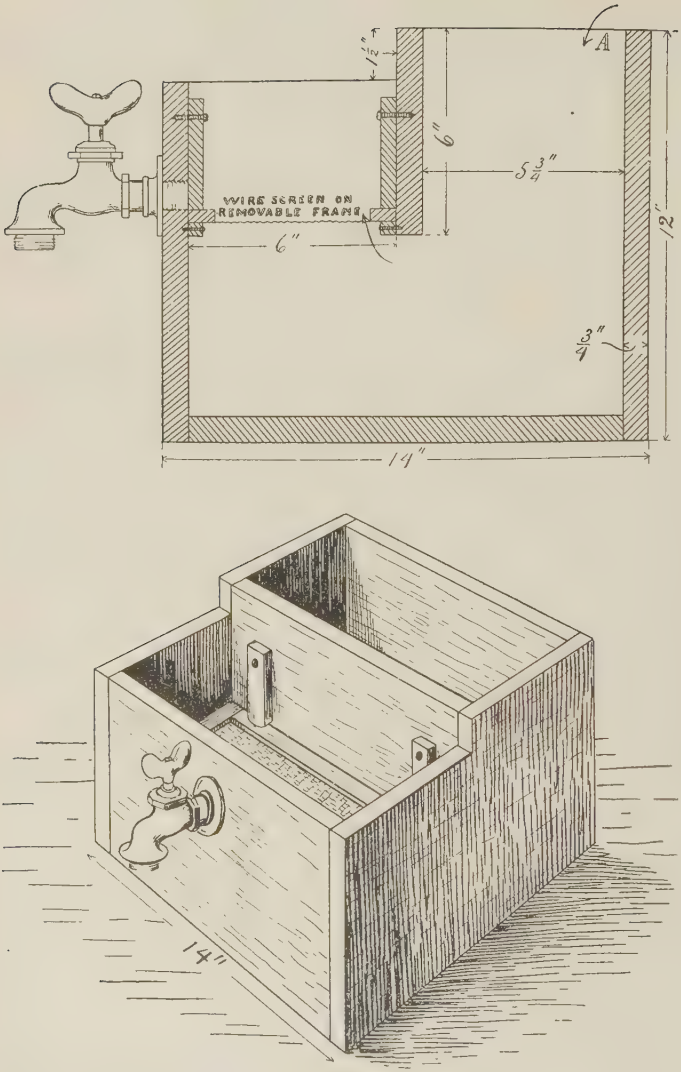


Fig. 1. Stewart's strainer. The sediment collects below the screen instead of on it and does not fill up the screen

lime slaked and made up to 50 gallons of water. Each gallon of stock solution now contains two pounds of the respective materials. To make a 4-6-50 Bordeaux, two gallons of copper sulphate stock solution is diluted to 15 or 20 gallons; three gallons of lime stock solution is diluted to the same amount and the two run into the spray tank at the same time. The resultant precipitate is diluted to 50 gallons and 50 gallons of Bordeaux is obtained. Bordeaux is a fungicide and is used for plant diseases. Alone it is worthless in the control of insect pests; therefore, some insecticide should always be used with it in summer work.

Self-boiled Lime-sulphur

Formula— 8 pounds sulphur
8 pounds lime (unslaked stone lime. Do not use hydrated lime or that which is air slaked)
50 gallons water

Self-boiled lime-sulphur is a comparatively new spray material as made at the present time and is used primarily for the control of the brown rot on the stone fruits. Its preparation is simple and should not be confused with that of boiled lime-sulphur. Self-boiled lime-sulphur is a simple mechanical mixture of free lime and sulphur, while boiled lime-sulphur is a mixture of complex chemical compounds of sulphur and lime. Self-boiled lime-sulphur is made by slaking eight pounds of good, high-grade stone lime in a tub or box. Just as the lime starts to slake, eight pounds of high-grade flowers of sulphur are sifted in. The slaking lime causes the lime and sulphur to mix thoroughly. After the lime has slaked for from 10 to 15 minutes, cold water should be added so as to stop the slaking. If this is not done, the lime may develop enough heat to cause the lime and sulphur to go into chemical combination which results in the formation of soluble sulphides that are highly injurious to peach leaves. The mixture of lime and sulphur is now diluted to 50 gallons and strained into the spray barrel. Great care should be taken to work through all of the sulphur as this is the material which exerts the fungicidal property. In making self-boiled lime-sulphur for orchard use, it is advisable to work with large quantities of lime and sulphur such as, 32 pounds of lime, 32 pounds of sulphur and 200 gallons of water. The heat developed from this large quantity of lime will better mix the lime and sulphur. This large mass of material will have to be thoroughly stirred, however, as the lime will have a tendency to cake on the bottom of the tub.

Boiled Lime-sulphur

Boiled or concentrated lime-sulphur can either be purchased in the commercial form or made at home. This material is used both as a dormant spray for the control of scale insects and as a dilute

summer spray for fungous diseases. Commercial lime-sulphur can now be purchased in almost every town of the state, from either the druggist or hardware dealer. This material should test from 32° to 33° Baume. Home-made lime-sulphur should be boiled according to the Geneva formula to get the best results.

Geneva Formula[1]—80 pounds high grade flowers of sulphur
40 pounds stone lime (high calcium lime should be used; magnesium lime is unsuitable)
50 gallons of water



Fig. 2. Making concentrated lime-sulphur at home. With a simple outfit of kettles and brick furnace, enough material may be made in early spring for the whole summer's supply

Forty pounds of stone lime are slaked in an iron kettle. Eighty pounds of sulphur are placed in an old dash churn or a churn improvised from an arsenate of lead or pickle keg and thoroughly mixed with a small amount of water. This sulphur paste is then mixed with the milk of lime in the kettle and enough water added to make 50 gallons. This mass is then actually boiled for 45 minutes. The heat will cause the lime and sulphur to go into definite chemical combinations which are soluble. The result is a clear brown solution through which floats a very finely divided black sludge. This sludge can either be removed by allowing it to settle out or can be drawn off with the lime-sulphur and applied to the trees. All through the boiling process the liquid should be kept up to the 50 gallon mark so that the finished product will be 50 gallons of concentrated lime-

[1]Developed by the New York Agricultural Experiment Station and reported in Bulletin No. 329

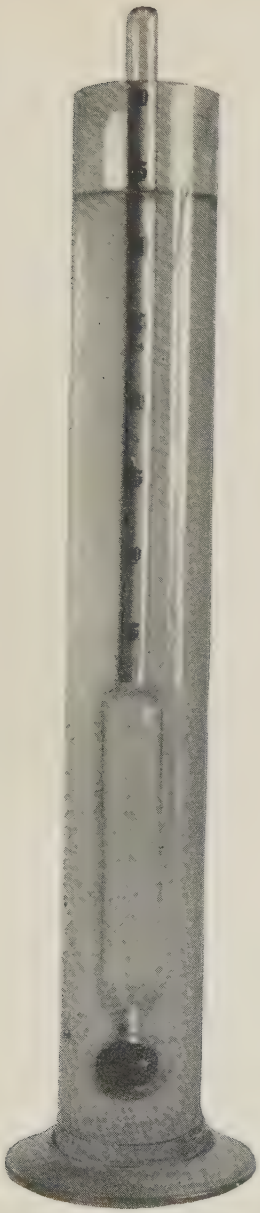


Fig. 3. Testing density of lime-sulphur in a glass cylinder by means of the hydrometer. The reading shows a density of six degrees Baume

sulphur. Home-made material will test anywhere from 25° to 28° Baume, depending on the quality of the materials used and the care taken in manufacture. By barrelling tightly, home-made material will keep just as well as commercial lime-sulphur. Concentrated lime-sulphur is used both as a contact insecticide for scale control and as a fungicide, the only difference being in the rate of dilution. For scale control the material is diluted so that the spray fluid will test 4.5° or 5° Baume. For summer work the concentrate is so diluted that the spray fluid will test 1° Baume. The rate of dilution is ascertained by means of the hydrometer.

This instrument is nothing more or less than a glass spindle so loaded at one end that it floats upright when placed in liquids. It is graduated to two scales, the specific gravity scale and the Baume scale. When placed in pure water at 60° F. the hydrometer reads 0° on both scales. When dropped into denser fluids the readings will vary with the density of the liquids. Every fruit grower should possess one of these little instruments. The most convenient hydrometer for use in testing lime-sulphur solutions is that known as the Pennsylvania pattern and may be purchased from dealers in spray materials or from the Bausch & Lomb Optical Company, Rochester, N. Y., for $1.00 each. Just as soon as a new barrel of concentrated lime-sulphur is opened, whether it be commercial or home-boiled, its specific gravity should be determined. This is done by drawing out a cylinder full of lime-sulphur and dropping the hydrometer into it. The scale is read at the surface of the liquid. The reading is then recorded on the barrel head and the dilutions made according to the following table:

Dilutions for Dormant and Summer Spraying with Lime-sulphur Mixtures

Reading on hydrometer		Amount of dilution Number of gallons of water to one gallon of lime-sulphur solution	
		For San Jose scale 5° Baume	For summer spraying of apples 1° Baume
Degrees Baume	Specific gravity		
35	1.318	9	45
34	1.306	8¾	43¼
33	1.295	8¼	41½
32	1.283	8	40
31	1.272	7½	37¾
30	1.261	7¼	36¼
29	1.250	6¾	34¼
28	1.239	6½	32¾
27	1.229	6	31
26	1.218	5¾	29½
25	1.208	5¼	27¾
24	1.198	5	26
23	1.188	4½	24¼
22	1.179	4¼	22¾
21	1.169	3¾	21¼
20	1.160	3½	19¾
19	1.151	3¼	18¼
18	1.142	3	17
17	1.133	2¾	16
16	1.124	2½	15
15	1.115	2¼	14
14	1.107	2	12¾

Miscible Oils

Numerous commercial houses are now placing on the market a soluble or miscible oil which will readily mix with cold water. These sprays are recommended by the manufacturers for scale control. When carefully handled they are very effective and are to be recommended to the careful grower.

Paris Green

Formula—6-8 ounces Paris green
50 gallons water or fungicide

Paris green as an orchard spray is now rapidly going out of use. Ever since the advent of spraying, Paris green has been the standard insecticide for chewing insects. Nevertheless, it has never given complete satisfaction as it settles too rapidly, does not adhere to the foliage as it should, and the excessive amounts of free arsenic which some Paris green contains often burn the tender leaves. However, it is still used by some orchardists. From six to eight ounces of Paris green should be thoroughly worked into a thin paste and added to 50 gallons of water or fungicide. If only water is used, about two pounds of lime should be added to every 50 gallons of water. This not only serves to neutralize the free arsenic of the Paris green, but also acts as a marker on the sprayed trees.

Arsenate of Lead

Formula— 2 pounds arsenate of lead paste
50 gallons water or fungicide

Arsenate of lead is now almost universally used as an insecticide for chewing insects, such as curculio, the larva of the codling moth, caterpillars, etc. It can either be bought in a commercial form or made at home. The commercial preparation is to be preferred. The prepared material is made both in paste and powdered form. The paste form is that most generally found on the market. Two pounds of arsenate of lead are mixed with water into a thin fluid paste and then added to every 50 gallons of water or fungicide. Arsenate of lead stays in suspension much better than does Paris green, it seldom burns the foliage, and it adheres very tenaciously to the leaves. On the whole it is a very satisfactory insecticide for chewing insects of all classes. When large amounts are used, as in general orchard spraying, it is advisable to make the lead into stock solutions. This is done by mixing a given weight of lead in a given volume of water so that each gallon of stock solution contains a known amount of lead. Make this quantity of lead into a paste by the use of either an old dash churn or a barrel churn. Dry arsenate of lead is twice as strong and costs about twice as much as the paste form.

SCHEDULE OF APPLICATION AND MATERIALS USED

Apple

Dormant Spray.—Applied as a sanitary measure and for the control of scale insects. Material used,—concentrated lime-sulphur diluted to test 5° Baume. Applied any time from November until the following March—during the dormant season.

First Summer Spray.—Applied for control of scab, curculio, canker worm, etc. Materials used,—concentrated lime-sulphur diluted to test 1° Baume and arsenate of lead at the rate of two pounds to every 50 gallons of dilute lime-sulphur. Apply just after the leaf buds burst but before blossoms open. This is the most important spray in the control of the curculio and scab and should be applied at the right time and in a careful manner.



Fig. 4. At this stage of development, just before the blossom clusters open, the orchard should be sprayed for scab, with dilute lime-sulphur or Bordeaux. Arsenate of lead is added for control of insects

Second Summer Spray.—Applied primarily as a control for the codling moth. Materials used,—same as first summer spray. Apply just after petals fall, before calyx lobes have closed over calyx tube. This is the most important spray for the control of the codling moth and should be applied just as soon after the petals fall as possible.

Where a large orchard is to be sprayed, it is often better not to wait until all petals have fallen, though spraying in full bloom is never advised. At this time a maximum amount of poison can be forced into the calyx tubes.



Fig. 5. Showing blossom cluster just after petals have fallen. This is the time for the most important spraying for codling moth. Thoroughness of application at this time is absolutely essential

Third Summer Spray.[1]—Applied for codling moth, curculio, scab, sooty blotch, rust, etc. Materials used,—same as first summer spray. Apply two or three weeks after petals fall.

Fourth Summer Spray.[1]—Applied for second brood of codling moth, scab, brown rot, etc. Materials used,— same as first summer spray. Applied about first week in July.

Fifth Summer Spray.—Applied for bitter rot, apple blotch, black rot, brown rot, codling moth, curculio, etc. Materials used,—4-6-50 Bordeaux and two pounds of arsenate of lead to every barrel of fungicide. Apply third or fourth week in July. Take pains to coat each fruit with spray. (To be applied in southern part of the state where bitter rot and blotch are prevalent)

[1] NOTE.—Where bitter rot, apple blotch, black rot, etc., are troublesome, the third, fourth and fifth sprays should be made with Bordeaux and arsenate of lead 4-6-50-2 instead of dilute lime-sulphur and arsenate of lead. Where these diseases do not appear, four sprays should be sufficient and dilute lime-sulphur and arsenate wholly replace Bordeaux

Pear

Dormant Spray.—Applied for San Jose scale and blister mite—same as apple.

First Summer Spray.—Applied for scab, leaf spot, curculio, etc. Materials used,—concentrated lime-sulphur diluted to test 1° Baume and arsenate of lead at the rate of two pounds to 50 gallons of fungicide. Applied just as fruit buds burst.

Second Summer Spray.—Same as first. Applied just before blossoms open.

Third Summer Spray.—Applied for codling moth, curculio, scab, etc. Material the same as first. Applied just as petals fall.

Fourth Summer Spray.—Applied for scab, codling moth, etc. Materials used same as first. Apply three weeks after petals fall.



Fig. 6. The time for the third spraying three to four weeks after petals fall

Quince

Same as pear.

Peach

Dormant Spray.—Applied for San Jose scale and leaf curl. Material used,—concentrated lime-sulphur diluted to test 4.5° to 5° Baume. Apply in March.

First Summer Spray.—Applied for curculio. Materials used,—arsenate of lead and lime—two pounds lead and two pounds lime to every 50 gallons of water. Apply 10 days after petals fall, or at time the shucks are falling.

Second Summer Spray.—Applied for brown rot and curculio. Materials used,—self-boiled lime-sulphur and arsenate of lead. Two pounds of lead to every 50 gallons of fungicide. Apply four or five weeks after petals fall.

Third Summer Spray.[1]—Same as second. Apply three or four weeks after second spray.

Fourth Summer Spray.—Same as second. Apply four or five weeks before the fruit ripens.

Plums[2]

Dormant Spray.—Applied for San Jose scale and general sanitary reasons. Material used,—concentrated lime-sulphur diluted to test 5° Baume. Apply any time during the dormant season.

First Summer Spray.—Applied for control of brown rot and curculio. Materials used,—Bordeaux and arsenate of lead, two pounds to 50 gallons of Bordeaux. Apply just after the buds burst.

Second Summer Spray.—Same as first. Apply just after petals fall.

Third Summer Spray.—Same as first. Apply three weeks after petals fall.

Cherries

Same as plums.

SPRAY OUTFITS

Satisfactory work in spraying cannot be accomplished without some form of a good spray outfit. The size of the outfit will, of course, vary with the size of the orchard to be sprayed. Orchards of from one tree to five acres can be cared for with a good barrel pump. From five to ten acres will demand a high pressure hand pump. A mature orchard of over 10 acres is large enough to warrant the use of one or more power outfits. In buying a spray outfit, whether it be large or small, we should keep in mind the following points:

1. *The Pump.*—It should be capable of developing from 85 pounds to 200 pounds pressure. It should have a large air chamber. The valves should be easy of access. It should be made of durable material and be easy of operation.

2. *The Agitator.*—Some good means of mechanical agitation should be supplied. The large paddle type for the barrel outfit or the propeller type for the power outfit are good.

[1] NOTE.—This spray is omitted for early sorts

[2] A 2-4-50 Bordeaux or self-boiled lime-sulphur should be used for plums with tender foliage such as the Japanese varieties

3. *The Hose.*—One or two leads of good hose are needed. The lead for ground work should be at least 35 feet long and the lead for the tower 15 feet to 20 feet. It should be from four to seven ply, depending on the pressure used, three-eighths inch to one-half inch in diameter and fitted with the best type of bands and clamps.

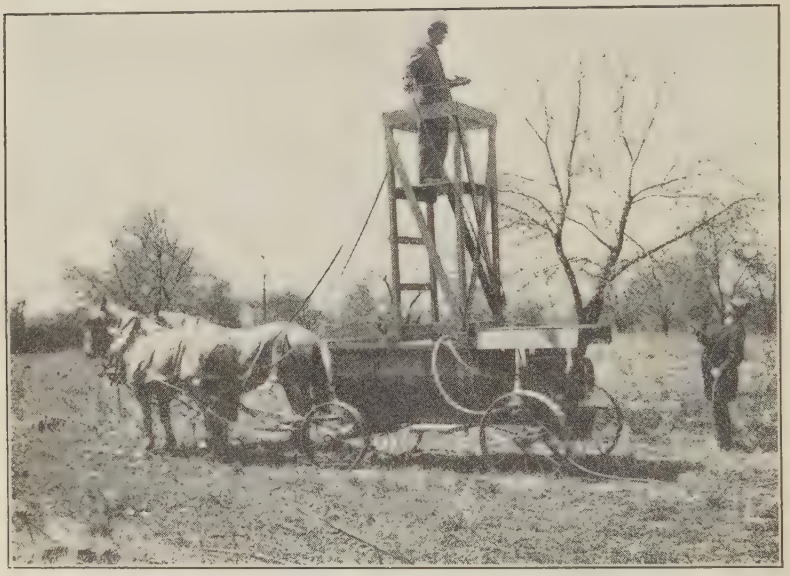


Fig. 7. Gasoline engine outfit. This type of sprayer will carry two or more leads of hose and is the best type for most commercial orchards

4. *The Extension Rod.*—Every outfit should be equipped with an extension rod for each lead of hose. They should be anywhere from eight feet to 12 feet long, should be bamboo lined with brass or aluminum or should be one-fourth inch gas pipe so wrapped as to give good hand hold and each equipped with leakless stop-cocks.

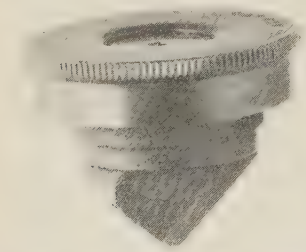


Fig. 8. The angle Friend type of spray nozzle. It is simple, compact and satisfactory. Cut shows natural size

5. *The Nozzle.*—The nozzle should *spray, not sprinkle.* The various makes of the large disk type are now giving the best satisfaction when used under high pressure.

When spraying, aim to do a thorough job. Slack work will never produce satisfactory results. Apply your material at the right time and in the correct manner and harvest a crop of fruit that will average 90 per cent. perfect fruit.

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 35

LaFayette, Ind., March, 1912

SUPPLEMENTARY PASTURE CROPS

M. L. Fisher, Department of Soils and Crops
F. G. King, Department of Animal Husbandry

The hog in his natural state is a foraging animal. Practically all forms of plant and animal life were consumed by wild swine in their search for food. So efficient, however, is the hog in converting grain into meat that it was formerly often the practice when corn was very cheap, to limit the fattening hog to an exclusive grain ration. The price of corn has been so high in recent years, however, that the most profitable returns could not be secured in pork production without considering the natural tendency of the hog and furnishing an abundance of pasture during the spring, summer, and fall. Lack of available pasture necessarily increases the cost of pork production.

The value of pasture is too generally known to need extensive discussion. Nevertheless, a few facts as to the actual reduction in the cost of producing pork by use of pasture may not be amiss. After several years' experiments including five trials in dry lot and 15 trials on various forage crops, the Missouri Experiment Station drew the following conclusions: "The average amount of grain to produce a pound of gain with five dry lot experiments was 5.11 pounds and that when well balanced rations were used. The average amount of grain to produce a pound of gain with hogs on forage crops was 3.54 pounds. The forage crops effected a saving of 30.7 per cent in the amount of grain to produce a pound of gain. We may safely conclude from the above experiments that gains made with forage crops are made at 20 to 30 per cent less cost than the gains produced largely with grain. These experiments have shown that the profits per acre of forage when pork

is worth six cents may range from $7.26 to $35.61 per acre. With pork at six cents the average value of a bushel of corn fed to hogs in dry lot was 66 cents per bushel; the average value of a bushel of corn fed to hogs on forage was 95 cents."

Red clover is the crop to be principally depended upon for hog pasture in Indiana. This is true not only because of its importance for completing the rotation of crops, but also because of its high value as a forage. So universal is the use of clover, that when there is a great shortage of this crop, the hog raiser is often at a very serious loss to know what to do for pasture. Very often the hogs are sold or are kept on inadequate pasture. Neither course is necessary. It is both possible and economical to sow some quick-growing crop, or a series of crops, in the spring and summer that will furnish an abundance of hog pasture of almost the same feeding value as clover and at very little extra cost in time and labor.

The disastrous effects of the drouth and other unfavorable conditions on the clover crop during the past year make the need of more knowledge of crops to sow for an early pasture especially urgent at this time. It is for the purpose of supplying information as to what crops can be substituted for clover as hog pasture this summer and at other times when the clover crop fails that this circular has been prepared. While it is feasible to sow red clover the first part of April on an especially well prepared seed bed without a nurse crop and obtain good pasture by the middle of the summer, the use of quick growing crops must largely be relied upon to furnish forage when the clover crop fails.

In the discussion of crops which follows, they are taken up in their relative importance as forage crops for hogs. These crops can also, with a few exceptions, such as roots and to a certain extent pumpkins, be used as forage for sheep, but are not of much service for cattle although they are sometimes used. Care must be taken with ruminants on quick-growing crops to prevent loss from bloating. Another serious drawback to the successful use of these crops as cattle pasture is that animals as large as cattle trample the rapidly growing crops so badly that proper plant growth is hindered. If they are used for cattle they should be used as soiling crops. Roots, however, are very valuable as winter feed for cattle and sheep as well as hogs.

RAPE

Rape is one of the most satisfactory crops for early hog pasture when clover is not available. It closely resembles cabbage in appearance and manner of growth, except that it does not produce a head. It has large, coarse, succulent leaves, and ordinarily grows from 20 to 30 inches tall. It is a cool weather plant and

can be sown early in the spring,—as soon as there is no further danger of severe frost. It will endure a pretty severe frost in the fall without injury and may be used for pasture late in the fall, provided the hogs are kept off when it is frozen. It is usually killed by such winters as we have in Indiana. The Drawf Essex and Dwarf Victoria are the varieties commonly grown.

After many years' experience with this plant Professor Carlyle at the Wisconsin Experiment Station found that with pigs from four to 10 months old an acre of rape when properly grown has a feeding value, when combined with a ration of corn and shorts, equivalent to 2436 pounds of the mixture of these grain feeds. The value of rape as compared with clover as found at the Wisconsin Experiment Station is shown in the following table:

	1898		1899	
	Rape	Clover	Rape	Clover
Number of pigs.....	19	19	21	21
Initial weight	111 lbs.	110 lbs.	101.9 lbs.	101.8 lbs.
Grain per 100 lbs. gain..	391 "	439 "	332 "	346 "
Daily gain per pig.....	.87 "	.78 "	1.27 "	1.22 "

It will be noted that there was not only a saving of grain but that the gains were more rapid with rape pasture than when clover was used. While the gains secured depend, of course, on the growth of both the clover and the rape, and trials do not always show the same results, nevertheless numerous trials at various stations have shown a high feeding value for rape pasture. At Purdue, rape has proved to be one of the most successful and abundant pastures that can be grown for hogs.

Rape is a gross feeder and does best on very fertile or heavily manured soil. It grows particularly well on old feed lots and lots used for yarding stock in winter. Rape does well also on muck land.

The seed bed should be prepared much the same as for corn, except that it should be especially well pulverized. The seed can be sown in drills or broadcasted. In drills the rows should be 20 inches or more apart and the plants cultivated the same as corn. Sowing in rows requires two or three pounds of seed per acre, while broadcasting requires four to six pounds. Sowing in rows has an advantage over broadcasting in that animals will follow the rows when feeding and thus will not destroy so many plants by trampling on them. This method also has an advantage when the crop is sown on foul land in that the cultivation helps to keep down the weeds. The seed can be distributed with a hand garden drill, or, on large areas, with a wheat drill by running the seed

from the grass seed attachment into the grain hoes. Broadcasting and harrowing in is also a common method.

Rape may be sown at any time during the spring and early summer, but the early seedings will give best returns. When sown for an all season crop it is usually sown during the first half of April. It is frequently sown with oats. After the oats are cut, the rape plants come on and furnish considerable pasture. If the stand of oats is thin, the rape plants may overtop them and furnish pasture much earlier. It is also frequently sown in standing corn at the last cultivation. It can be sown later and covered with a harrow-tooth cultivator, or with a mower wheel dragged between the rows.



Fig. 1. Pigs in rape pasture

When pasturing rape with large hogs they should not be turned on until the plants are 12 to 14 inches, or still better 16 to 18 inches high. When only small pigs are used, they should be turned on when it is about eight inches high and not too rank for their easy consumption. When pastured before this time the hogs pull the plants and kill them and thus destroy the pasture. Neither should it be pastured so closely that all leaves and stems are eaten, otherwise it will have to be sown again before the pasture can be renewed. A few leaves or parts of leaves should be left on the stems to start new growth. The hogs will eat the leaves first and not harm the stems seriously until all the leaves are gone; therefore, the hogs should be removed before the stems are injured. When this is done, new leaves spring out on the old stems and the pasture is renewed in much less time than when the stems are eaten off. For this reason two pastures should be provided so that

while one is being pastured the other is growing. When this is the case and the hogs are alternated between the two pastures, an acre of rape often furnishes enough forage for 15 to 20 hundred-pound hogs during a large part of the summer. Since rape can be sown at any time during the growing season, the pasture can be secured at almost any time during the summer and fall. It can be pastured late in the fall, but stock should be kept away from it while the leaves are frozen, otherwise the plant will be seriously injured and, also, the animals may scour badly. There is often complaint that hogs in rape become blistered, especially about the nose and ears. This is due to the hogs being in the rape while the dew is heavy or after a rain. While this is not an extremely serious objection, nevertheless it can be largely eliminated by keeping the hogs off while the rape is wet, and also by pasturing the rape close enough so that it does not become very rank in growth and greatly overtop the hogs.

COWPEAS

The cowpea is a legume producing much forage and considerable grain. It requires about 90 days from the time it is planted until it is developed sufficiently for pasturing. However, varieties differ in this respect, and late plantings develop more quickly than early plantings. It is ready to pasture when the first pods show signs of ripening. The Whippoorwill and New Era varieties are widely grown in Indiana. The Early Blackeye and Michigan Favorite are also grown to some extent. The last two are somewhat earlier than the others and are most used in the northern part of the State. The New Era usually produces more seed than the other three. While the cowpea has given good returns in all parts of the State, it is more certain in the southern half.

The value of cowpea pasture for hogs is well understood and appreciated by the farmers living in those portions of the State in which this plant has become a common forage crop. A trial was conducted by the Alabama Experiment Station in which a full feed of corn was given for 42 days to fifty-pound hogs running on cow pea pasture when the pods were ripening. One lot of three pigs was fed corn alone in a dry lot, while the other with an equal number of pigs was on the cowpea forage. The results were as follows:

	Daily gain	Grain per pound gain
Corn alone	.36 lbs.	5.86 lbs.
Corn and cowpeas	.97 "	3.07 "

It will be noted that the gain on these fifty-pound shotes was doubled when they were allowed to run on cowpea pasture. The corn required to make a pound gain was little more than half as much when fed on cowpea pasture as when fed alone in dry lot.

It has been shown that it is better, however, to feed corn and cowpeas in combination rather than separately. The cowpea has an excess of protein, while corn is deficient in this nutrient. Therefore, a combination of the two makes a better ration than either alone. Cowpeas sown in the corn and the entire crop pastured down by the hogs gives one of the best returns that can be secured from land. When sown in this way, as high as 900 to 1000 pounds of gain per acre have been secured on hogs. Another satisfactory way of pasturing corn and cowpeas is to have them in separate adjoining fields and allow the hogs to run from one to the other. It is sometimes necessary with both hogs and sheep to teach them to eat cowpea forage by feeding it to them in dry lot for a few days before turning them on the pasture.

The cowpea will grow on almost any type of soil, and will do better on sandy soils and some of the poorer clay soils than most crops. Like any other crop, it gives largest returns from good land. The seed bed is prepared the same as for corn. Being a warm weather plant, the cowpea should not be planted until the ground becomes warm, and usually not until after corn planting. It may be planted with success from corn planting time until the middle of July, especially in the southern half of the State.

The seed is planted in rows and cultivated, or sown broadcast and harrowed in, or drilled solid the same as wheat. When planted in rows, the rows should be 20 inches or more apart and the plants should stand two to three inches apart in the row. Drilled in rows, 20 to 30 pounds of seed per acre are required, according to the distance between rows. When drilled solid, one bushel (60 pounds) is necessary, while broadcasting will require still more seed. The seed can be distributed with a one-horse drill, or with a two-horse corn planter, using the small plates and rapid movement of the gear. A grain drill can also be used. With a grain drill there is danger of many seeds being broken, but this can be avoided to some extent by using the oats cups with which most modern drills are equipped. A few trials with the drill on solid ground will determine about where the gauge should be set to distribute the seed two or three inches apart. Planting in rows and cultivating will give largest yields.

Cowpeas are frequently sown in standing corn at the time of the last cultivation. They can also be sown after a crop of wheat or other early harvested crop has been removed, providing it is not too late in the season. Such sowings are usually not cultivated. They can not be expected to give such large yields as early plantings and are likely to be frosted.

The cultivation of cowpeas should be the same as for corn, except that they should not be cultivated when wet with dew or rain. Cultivation at such times induces an unthrifty condition of the plants.

Land which has never produced cowpeas should be inoculated, especially in localities where the crop is new. This is done by getting soil from a field in which cowpeas have grown successfully and where it is known that nodules, in abundance, were on the roots of the cowpeas. This soil can be screened, and a small amount mixed with the seed and allowed to feed out with it from the drill box when planting, or 200 pounds or more of the soil per acre can be scattered over the field and harrowed in. The harrow should follow the scattering of the soil immediately to prevent the sun killing the bacteria.

When sowing cowpeas for hog pasture, it should be borne in mind that they will not be available for pasture until late summer or early fall because it is necessary, in order to get the greatest good from the crop, to keep the hogs off it until the pods are beginning to ripen, otherwise the vines will be so badly trampled that the grain yield will be reduced. Therefore, for early pasture cowpeas are not as satisfactory as some other crops, but for late summer and fall pasture they yield very satisfactory returns.

SOY BEANS

The soy bean is another legume. Some varieties grow tall, slender, and weak, and show a tendency to vine, but most varieties have an upright, bushy growth. The soy bean is both a grain and a forage producer. There is a wide variation in the time of development of different varieties, but those best adapted to Indiana will be ready to pasture in about 80 to 90 days from planting. Midsummer sowings will develop more quickly than the early sowings. The Ito San, Early Brown, Mikado, Black Beauty, and Hollybrook are well known varieties. The Ito San and Early Brown are adapted to any part of the State; the Mikado, Black Beauty, and Hollybrook to all parts, except the northern counties.

The character of forage furnished by the soy bean is much the same as that of the cowpea. However, it produces a much larger percentage of grain to forage than does the cowpea and the grain contains a higher per cent of protein. It is far more valuable for the feeding quality of its grain than of its leaves. It is entirely possible to secure forage for 20 to 30 hogs per acre for four to six weeks in the fall and make exceedingly rapid and economical gains on them. From the result of several trials at this station it has been found that the threshed soy beans are worth practically as much per ton for fattening hogs as linseed oilmeal, and that very rapid and economical gains can be made by the use

of this plant whenever satisfactory growth is secured. The nature of the soy bean is such that it requires only about one part of the bean to four or five parts of corn to produce the most rapid and economical gains. Therefore, hogs on soy bean pasture should be given a full ration of corn.

All that has been said concerning the culture of the cowpea is equally true of the soy bean and need not be repeated. The soy bean, like the cowpea, should have inoculation. Soil from a field in which soy beans have been grown successfully should be used.

Soy beans should be pastured much the same as cowpeas. The hogs can sometimes be turned on while the plants are growing. This is a very doubtful method, however, because the pasturing must be very light in order to prevent too large a decrease in the grain yield. When pastured in this manner the hogs should be removed from the soy beans long enough, when the pods are forming, to allow the latter to fill and begin ripening after which the hogs can again be turned on and allowed to harvest the field. The best method of pasturing soy beans is to allow the pods to begin ripening before the hogs are turned on. This permits the greatest development of grain in which the chief value of this crop lies. Soy beans are very valuable for winter feed for balancing the ration of corn and can be fed ground and mixed with the corn.

CANADIAN FIELD PEAS AND OATS

The Canadian field pea is a legume that closely resembles the garden pea. It must not be confused with the cowpea, which resembles the bean and is a warm weather plant and not adapted to the cooler climates in which the Canadian field pea thrives best. The Canadian field pea is well adapted to the northern third of the State and in very early sowings further south. It is usually sown in connection with oats, and so combined it furnishes one of the earliest forage crops, either for cutting green or for pasturing. As the seed comes on the market, there is usually no distinction made as to the varieties, but the Golden Vine, Yellow Canada, Green Canada, Prussian Blue, and Tall White Marrowfat are common varieties.

The quality of forage of the Canadian field pea is not greatly different from that of the clover plant. Its chief value lies in its forage, because it seldom produces a profitable crop of seed in this state. It should always be sown with oats; otherwise it will trail on the ground, rot, and be badly trampled when pastured. This mixed pasture often furnishes a very valuable forage crop and comes earliest in the season of any of the rapid-growing leguminous pastures. From several years' trials at this station, it has been found that very satisfactory gains can be secured on this kind

of pasture, but that when hot weather begins early in the summer, the growth of forage is sometimes too small to produce satisfactory returns per acre.

The Canadian field pea is adapted to almost any soil, but does best on rich corn land. The mixture of peas and oats should be sown as early in spring as the ground can be worked. For a succession of crops one or two later sowings can be made at intervals of 10 days or two weeks. The mixture will be ready to pasture in about five or six weeks from the time of sowing.

The usual method of sowing is to scatter the peas broadcast over the surface of the ground and then turn under about three inches deep, harrow down, and drill the oats at once or a few days later. It is better to disk the ground before broadcasting the peas. About one and a half bushels each of peas and oats are used to an acre. If the peas are sown alone a little heavier seeding should be made.

In pasturing, the hogs can be turned on when the peas and oats are six to 10 inches tall and continued as long as satisfactory forage can be secured. If the crop is not grazed closely enough to prevent seed formation the hogs should be removed when the pods are forming and not returned until the pods are ripening. It is not common, however, to allow seed to form on peas used as hog pasture.

RYE

If one knows in the autumn before, that he will be short of hog pasture in the spring, there is nothing better to sow for early pasture than rye. When sown in September at the rate of one to one and a half bushels per acre, it will give the earliest spring pasture that can be obtained. If sown in August, it will give excellent late autumn as well as early spring pasture.

The forage furnished by rye pasture is of about the same quality as that of wheat or timothy. Its chief value lies in its earliness. It can be pastured at any time in the fall or winter when it is large enough to furnish pasture. After rye has begun jointing in spring, the hogs should be removed and the field either plowed and put in corn or allowed to ripen its grain, which can either be "hogged down" or cut and threshed. For winter and early spring pasture, rye sown in corn in August will not only furnish large amounts of forage but will also induce exercise on the part of the hogs. Exercise is of incalculable value to hogs and especially so to growing and breeding animals.

OATS

Oats will furnish a good pasture during the spring and early summer. For pasture the seeding should be heavy,—about three bushels or more of seed per acre. It is sown on either plowed or stubble ground. When sown on plowed land, it is usually drilled,

while on the stubble ground it is frequently sown with a broadcast seeder and covered by disking and harrowing. When sown for hog pasture alone, it is better to sow in connection with rape or Canadian field peas, because both the quantity and quality of pasture is improved.

Oats can be pastured from the time they are three or four inches high until the heads are forming. At this time the hogs should be removed until the grain is in the milk, when, if desirable, they can again be turned in and allowed to harvest the grain crop. Oats are especially good for sows and pigs because they furnish early pasture. The composition of the oat plant is such that it does not furnish the proper amount of nutrients to balance a ration of corn for growing hogs. Hence, on oat pasture the hogs should have a limited amount of nitrogenous supplements, such as middlings, linseed oilmeal, or a small amount of tankage or meat meal.

VETCH

Vetch is also a legume. Its adaptation as a pasture plant is not well established. Some farmers have reported favorably on its use. There are two types, spring vetch and hairy vetch. The latter is also designated as "sand vetch" and "winter vetch." Only the hairy vetch is adapted to Indiana. It should be sown in July or August on a good seed bed at the rate of one bushel (60 pounds) per acre. It will not furnish much, if any, feed in the autumn. It is not entirely hardy and frequently winter-kills.

It is very difficult to pasture vetch without having the plants severely injured by the trampling of the animals. The character of forage is similar to that of the other legumes. It is better to cut the vetch and use it as a soiling crop than to pasture it.

CRIMSON CLOVER

Crimson clover is related to the red, mammoth, and alsike clovers but unlike these, it should be sown in July or August. With proper moisture conditions it will grow rapidly and produce a very considerable amount of pasture during the autumn. One bushel of seed will sow five or six acres. The seed should be covered by harrowing, or drilling very shallow. As a general rule, however, it is unsafe to depend on satisfactory returns from this plant on account of winter-killing.

The feeding value and the method of pasturing crimson clover are so nearly the same as with red clover that nothing special need be said concerning this phase of the subject. Anyone familiar with the pasturing of clover with hogs needs no directions as to the handling of hogs on crimson clover.

SORGHUM

Sorghum, in a general way, resembles corn and requires the same seed bed preparation and cultivation. It will grow on any soil, but should not be planted until the ground is thoroughly warm. It is usually drilled in rows 24 inches or more apart, using a grain drill and setting the gauge to sow about half a bushel of wheat per acre. About a peck to a half bushel of seed is required per acre.

Sorghum, while it is better than no pasture at all, does not occupy as prominent a place among the quick-growing forage crops for hogs as do the other plants mentioned. It is a bulky feed and is more suitable to ruminants, such as cattle and sheep, than to hogs. It has one serviceable place, however, in that it is good to help carry the brood sow through the summer months economically when other pastures are short. It is also valuable for soiling purposes if cut when almost ripe and thrown into the pen for growing or fattening hogs. It is not as nutritious as the other forage crops mentioned, but is sometimes the most valuable crop during hot weather. Sorghum is not recommended for hog pasture when any of the crops previously mentioned can be secured.

When sown in May, sorghum may be ready for pasture by July. The hogs can either be turned on when it is a foot to a foot and a half high, or the crop can be allowed to grow until almost ripe before being pastured. The latter method, however, requires that the hogs either learn to break down the stalks or that the sorghum be cut and thrown into the lot for them. The former method requires so much exercise on the part of the animals that this form of pasture is unsatisfactory for fattening hogs.

ROOT CROPS

The most common and by far the most important use of root crop is for storing and feeding as a succulent feed for stock in winter. They furnish succulent forage that keeps the digestive organs of the animal in perfect condition. In addition to the large amount of nutrients furnished, they act as conditioners and put the animal in condition to make the best use of other feeds. Root crops are sometimes used as pasture. The Michigan Experiment Station found that sugar beets and mangels would produce, when fed in combination with grain, as high as seven or eight hundred pounds of pork per acre when the hogs were allowed to gather the roots themselves. These root crops include mangels, sugar beets, and carrots. The artichoke, though really a tuber, is generally classes with the root crops. While the root crops are valuable for winter feed and to some extent for pasturing, the intensive methods of culture necessary are such a drawback to their production that they are not in very general use as stock feed.

When harvested and stored for winter feed, the roots are pulled in October. Plowing a furrow along one side of the row

makes the pulling easier. After being topped and dried they can be stored in a box stall, root cellar, or covered with earth. They should not be kept too warm, neither should they be be allowed to freeze to any extent.

Artichokes.—The artichoke is a coarse plant growing several feet tall, with yellow blossoms and is related to the wild sunflowers. The part desired is the tuberous, underground growth which very much resembles the potato in appearance. Any land which will produce potatoes will also produce a good growth of artichokes. The planting and cultivation of artichokes are very much the same as for potatoes. However, artichokes may be planted in the autumn by dropping them in the furrow as the ground is being plowed. With some cultivation in the spring the crop will take care of itself. Artichokes need not be replanted every year as they will live over in the ground and come up in succeeding years. In fact, they very frequently become weeds when allowed to escape cultivation. They are highly productive and furnish an abundance of food material per acre.

Artichokes should be planted near the hog lot and be harvested by turning the hogs in and allowing them to root the tubers out of the ground. One acre will often furnish pasture for from 15 to 25 hogs from October until the ground is frozen. Results from the Oregon Experiment Station show that compared with grain alone the artichoke effected a saving of nearly two pounds of grain per pound of gain on hogs.

Mangel Wurtzels.—This crop is usually designated by the term "mangels." Mangels are closely related to the sugar beets, in fact the sugar beet is only a developed form of mangel wurtzel. The mangel wurtzel requires rich, deep soil, well drained, and as free as possible from weeds. Well rotted stable manure is an excellent fertilizer. The ground should be plowed deep and prepared to a very fine seed bed. The seed is planted in rows 20 inches or more apart and thick enough so that when thinned, the plants may stand six to 10 inches apart in the row. About six pounds of seed are needed for an acre. The plants grow slowly at first, but after they have four or five leaves, they grow rapidly. When about four leaves are developed the plants should be thinned so as to stand six to 10 inches apart in the row. This usually has to be done by hand. Subsequent cultivation should be given to keep the soil free from weeds and preserve a soil mulch.

Mangels should be pastured about the same as artichokes. They are more readily eaten than other root crops, because a part of the tuber stands above the ground. This latter condition, however, is somewhat objectionable because it permits early damage by frost. Also, there is some danger of scouring among hogs pasturing mangels, unless they are also fed rather heavily on grain.

Sugar Beets.—The sugar beet is similar to the mangel wurtzel in every respect, except that it does not grow so large and is richer

in sugar. It requires, in every way, the same cultural treatment as mangels and furnishes much the same amount and character of pasture and should be pastured in the same way.

Carrots.—The carrot is also a plant raised for the enlarged tap root. It also requires rich, deep soil free from weeds. Seed should be sown in the spring about the first of May or a little later in rows 20 inches or more apart so that they can be cultivated. The seed should be sown rather thick so that when thinned the plants will stand three or four inches apart in the row. Two or three pounds of seed per acre are used. The thinning is done after the plants have attained some considerable size. The young plants are delicate and thinning is rather a tedious process and as a rule the raising of this crop is more difficult than is the raising of mangels or sugar beets. Carrots should be pastured in the same way as mangels and the other root crops mentioned.

PUMPKINS

For late summer and fall, pumpkins may be of much use for hog feed. The Oregon Experiment Station found that two-hundred-pound hogs receiving a small amount of shorts and all the pumpkins they would consume gained about a pound and a half daily. The average of three trials at different stations shows that 273 pounds of grain and 376 pounds of raw pumpkin produced a hundred pounds of gain. The pumpkin is a hot weather plant and seed should not be planted until the ground has become thoroughly warm. It will grow on any good corn land. The common method of growing them is to plant the seed in the hills or rows of corn in the corn field. For large yields of pumpkins they should be planted alone in hills about six or eight feet apart. A good stand is two plants in a hill. Nevertheless, several seeds should be planted in each hill to provide for destruction by insects. Three or four pounds of seed will plant an acre. The plants should have cultivation until they begin to vine, after which they will take care of themselves.

The character of the pumpkin makes it better to feed with corn than with a more bulky ration as is shown by a trial at the New Hampshire Experiment Station where two lots of shotes were fed on raw pumpkin. One of these lots received, in addition, milk and the other milk and corn meal. The first lot made a gain of 1.12 pounds daily per head, while the latter made a gain of 2.26 pounds. Pumpkin seeds are very rich in protein and also act as a vermifuge, clearing the animals of worms and putting the digestive organs in excellent condition. There is nothing better for putting the animal in good tone than pumpkins, but care should be taken that too many seeds are not eaten and the animal's system thereby deranged.

TABLE I.—PASTURE FOR HOGS BY MONTHS

Month	Name of crop	Date of sowing	Approximate length of time crop affords pasture	[1] No. of 100-pound hogs per acre
April	Rye	August or September	Six weeks	10-15
May	Oats	March 20 to April 10	Six weeks	8-12
	Oats and rape	March 20 to April 10	Four weeks	12-20
	Oats and Canadian field peas	March 20 to April 10	Four weeks	12-20
	Rape	April 1-10	Four weeks	12-15
June	Rape and oats	April 10-30	Four weeks	15-20
	Canadian field peas and oats	April 10-30	Four weeks	12-15
	Rape	April 10-30	Four weeks	12-20
July	Rape	April 1-10 and grazed down in May	Four weeks	12-20
	Rape	May 1-20	Four weeks	12-20
	Clover, red or mammoth	Mar. 25 to April 10 without nurse crop	Remainder of season	8-10
	Sorghum	May 10-20	Four weeks	15-20
August	Clover, red or mammoth	Spring sown	Remainder of season	8-10
	Rape	Apr. 10-30 and grazed down in June	Four weeks	12-20
	Rape	June 1-15	Four weeks	12-20
	Sorghum	May 20-30	Four weeks	15-20
	Soy beans or cowpeas	May 20 to June 1	Six weeks	12-18
September	Clover, red or mammoth	Spring sown	Remainder of season	8-10
	Soy beans or cowpeas	May 20 to June 15	Six weeks	12-18
	Rape	Second or third growth	Four weeks	12-20
	Rape	June 20 to July 10	Four weeks	12-20
	Pumpkins	May 15 to June 15	Fed in lots	
	Sorghum	May 20 to June 15	Fed in lots	
October	Clover, red or mammoth	Spring sown	Remainder of season	8-10
	Rape	Same as September	Four weeks	12-20
	Rye	August 1-30	Remainder of season	8-10
	Soy beans or cowpeas	June 1 to July 15	Four weeks	12-20

[1] These figures are estimated on the basis of the length of time the crop affords pasture

This table shows the crops which may be planted to furnish green feed for any particular month, or months, of the growing season. It is not expected that a farmer would want all of the different crops mentioned under any one month, but several are mentioned in order to furnish a choice. Suppose, for example, a farmer knows that he will need pasture in August. Under August are given five crops, any one of which will propably furnish all the pasture desired. The table shows when such crop should be sown and the approximate number of animals per acre for which it will furnish pasture. In Table II is shown the probable cost of the seed and the amount necessary per acre. The tables thus enable the farmer to make a choice suitable to his needs.

[1]TABLE II.—PLANTING TABLE OF FORAGE CROPS FOR HOGS

Crop	Date of sowing	Method of sowing	Rate of sowing per acre	Time from sowing until ready for use	Approximate length of time crop affords pasture	Approximate cost of seed	Remarks
Rape	April 1 to July 10	Rows or broadcast	2 to 6 lbs.	6 to 8 weeks	4 weeks	6 cts. to 10 cts. per lb.	Can be pastured several times. Renews growth after being grazed
Cowpeas	May 25 to July 15	Rows or drilled solid	½ to 1½ bus.	80 to 100 days	4 to 6 weeks	$2.25 to $3.50 per bu.	
Soy beans	May 20 to July 15	Rows or drilled solid	½ to 1½ bus.	70 to 90 days	4 to 6 weeks	$2.25 to $3.00 per bu.	
Canadian field peas	Mar. 20 to Apr. 30	Drilled or broadcast	1 to 1½ bus.	6 weeks	3 to 5 weeks	$2.50 to $3.50 per bu.	Should be sown with oats. Of most value in northern counties
Rye	August or September	Drilled or broadcast	1 to 1½ bus.	Late autumn Early spring	4 to 6 weeks	75 cts. to $1.25 per bu.	August sown rye furnishes good autumn pasture. Earliest spring pasture
Oats	Mar. 20 to Apr. 10	Drilled or broadcast	2 to 3 bus.	5 to 6 weeks	4 to 6 weeks	40 cts. to 70 cts. per bu.	When sown with Canadian field peas can be sown as late as May 1
Vetch	July 1 to Sept. 15	Drilled	40 to 60 lbs.	April and May following year	4 to 6 weeks	10 cts. to 15 cts. per lb.	
Crimson clover	July or August	Broadcast	10 to 12 lbs.	8 weeks	3 to 4 weeks	$8.00 to $12.00 per bu.	If not winter killed, will furnish good spring pasture. Of doubtful value
Sorghum	May 10 to June 15	Rows or drilled	Rows 15 lbs. Drilled 30-45 lbs.	6 to 8 weeks	4 to 6 weeks	6 cts. to 10 cts. per lb.	
Root crops	May 1 to 30	Rows	4 to 8 lbs.	4 months	According to quantity	25 cts. to 50 cts. per lb.	Best for storing for winter feed
Artichokes	Autumn or spring	Like potatoes	10 to 15 bus.	Following autumn	According to quantity	$1.25 to $3.00 per bu.	Can be pastured either in autumn or spring when once established
Pumpkins	May 15 to June 15	Hills	4 to 6 lbs.	120 days	According to quantity	20 cts. to 35 cts. per lb.	

[1] Some of the plants mentioned have special adaptability to certain parts of the State and cannot be generally used. The dates of sowing and the amounts of pasture furnished by each crop also vary in different parts of the State. The dates given both for sowing and pasturing are approximated, but in general, the earlier dates are for the southern section and the later dates for the northern section of the State

Table III.—Suggested Succession of Forage Crops for Pasture for Hogs

NORTHERN COUNTIES

Crops	Approximate date of sowing	Time for pasturing
SERIES I		
Peas and oats	March 20–April 1	May 1 to May 20
Peas and oats	April 1–15	May 15 to June 15
Peas and oats	April 15–30	June 10 to July 10
Rape	May 1–15	July 1 to August 10
Rape	May 20–30	August 1 to September 1
Cowpeas or soy beans	May 20–June 10	August 20 to October 15
Rye	August or September	October 15 to November 15
SERIES II		
Rye	August or September	April 1 to May 10
Wheat	September	May 10 to June 1
Canadian peas and oats	April 1–10	June 1 to June 15
Rape	April 15–30	June 10 to July 10
Clover, red or mammoth	March 25—April 10	July 15 to Aug. 15
Soy beans	May 20–30	Aug. 15 to Sept. 1
Cowpeas	May 20—June 10	Sept. 1 to Oct. 1
Rye	August	Oct. 1 to freezing weather

ALL PARTS OF STATE

Crops	Approximate date of sowing	Time for pasturing
SERIES III		
Oats	March 20—April 10	May 1 to June 1
Rape	April 1–15	May 25 to July 1
Rape	April 15—May 1	June 25 to July 25
Clover, red or mammoth	March 25—April 15	July 15 to Sept. 1
Cowpeas or soy beans	May 20—June 10	Aug. 25 to Oct. 15
Rye	August or September	Oct. 1 to freezing weather
SERIES IV		
Rye	August or September	April 1 to May 15
Rape	April 1–10	May 15 to June 15
Rape	April 20–30	June 15 to July 15
Rape	April 1–10 (grazed down once)	July 10 to Aug. 1
Clover, red or mammoth	March 25—April 10	July 15 to Sept. 1
Cowpeas	May 20–30	Aug. 20 to Oct. 10
Rye	August	Oct. 1 to freezing weather
SERIES V		
Rape and oats	April 1–10	May 15 to June 15
Rape	April 20—May 1	June 10 to July 15
Rape	Alternate between the previously sown fields	July 15 to Nov. 15

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 36

LaFayette, Ind., March, 1912

AGRICULTURAL EXTENSION
XVI

HOW TO GROW ALFALFA

A. T. Wiancko and M. L. Fisher
Department of Soils and Crops

Alfalfa may be successfully raised on almost any type of soil, provided that it is well drained, sweet, free of weeds, and well supplied with organic matter and mineral plant food.

Good drainage must be provided.

The ground must be free of weed seeds.

If the soil is sour, it must be limed before alfalfa can do well.

Soils lacking in fertility should be well manured, as alfalfa requires large amounts of plant food.

Inoculation of the soil will generally be necessary and must not be neglected. Soil from a good alfalfa field or from a place where sweet clover is growing should be used for inoculating.

The best land on the farm should be used for the first trial of alfalfa. If successful, it will pay better than any other crop.

Alfalfa is an excellent feed for all kinds of live stock.

It is rich in flesh forming and milk producing nutrients.

It is more digestible than red clover and is not far behind such materials as wheat bran in feeding value.

Alfalfa will yield from three to six tons of hay per acre per season, according to the fertility of the soil.

INTRODUCTION

There is now no longer any doubt concerning the adaptation of alfalfa to Indiana conditions. Its high feeding value and its ability to produce large yields are established facts. Many farmers in various parts of the State are successfully producing large areas of it and their experience and the experiments of this station, which have extended to practically every county, have shown that its successful production is simply a matter of understanding its requirements. In every neighborhood the interest in its production is becoming more and more marked and the time is not far distant when this valuable forage crop will play an important part in Indiana agriculture.

As with all crops that are new to the farmer or to the local conditions, there is much to be learned about alfalfa before it can be successfully produced. The nature of the plant must be carefully considered and its habits of growth, its needs in the way of plant food, the soils best suited to it, and its cultural requirements must be understood. Without such knowledge much disappointment is likely to result, and no one should attempt to raise alfalfa without first making a thorough study of the subject. When once understood alfalfa is easily produced and the large profits that may be secured from it make it well worth while to devote some study to its requirements.

Recognizing the value of the crop and its possibilities for better agriculture, this station began experiments with it in 1903 with the purpose of finding out its cultural requirements. In recent years these experiments have been conducted in large numbers throughout the State, on all the principal soil types and in practically every county. As a result of these investigations, there has been collected a large amount of valuable information concerning the requirements of alfalfa, its behavior under different surroundings, and the best methods of dealing with it.

During the past year the experiences of nearly 300 successful alfalfa growers, representing all parts of the State, have been collected and carefully studied and much has been added to our knowledge of the causes of success or failure and we are more than ever convinced of the large possibilities of the crop in Indiana.

Nearly every county has its alfalfa growers and in some counties it has become a common crop. Many farmers have considerable areas of it and are finding it by far the most profitable crop on the farm.

In the following pages the principal points which need to be considered and the methods of dealing with them are briefly discussed. All of these points are important and should be carefully studied.



Fig. 1. Single alfalfa plants, showing nodules on roots. These plants were secured May 23 from a field seeded August 17 of the preceding year

FEEDING VALUE OF ALFALFA

As a food for all kinds of live stock alfalfa is the king of forage crops. It is especially rich in protein and is well adapted for use in a feeding ration with corn which is relatively low in protein content. It makes excellent hay and is more digestible than most forms of rough feed. Numerous feeding trials with alfalfa have shown that it is worth fully a half more than clover hay and many feeders claim that it is almost equal to such materials as wheat bran.

At the Illinois Experiment Station[1] a test of the value of alfalfa as compared with timothy for dairy cows showed that a ration composed of mixed grain, corn stover and alfalfa hay produced 834 pounds more milk per ton of hay fed than a ration in which an equal amount of timothy hay was used instead of the alfalfa. The milk produced during this test was sold at $1.30 per 100 pounds which made a ton of alfalfa hay worth $10.86 more than a ton of timothy hay. In another test where an equal amount of alfalfa hay was substituted for bran in a ration otherwise composed of clover hay, corn silage and corn meal, the ration containing alfalfa produced more milk but slightly less butter fat than the ration containing bran, showing alfalfa hay to be equal to or a little better than bran for milk production when used in this way. At the Nebraska Experiment Station[2] the average of three feeding trials with steers showed that the cost of 100 pounds gain was $8.32 on a ration of corn and prairie hay and only $6.29 on a ration of corn and alfalfa hay.

As a pasture and soiling crop it has few, if any equals, and one of the qualities which recommend it most highly is its rapid growth. For soiling purposes it can be cut four or five times in a season and for hay it will usually yield three good crops in Indiana, and sometimes four. As a pasture for hogs it is unexcelled. It is not only good feed, but helps to keep the animals in a healthy, vigorous condition. It also makes excellent pasture for cattle, sheep and horses.

[1]Illinois Bulletin No. 146

[2]Nebraska Bulletin No. 100

TABLE I.—TOTAL POUNDS OF DRY MATTER AND DIGESTIBLE NUTRIENTS IN 100 POUNDS OF ALFALFA, RED CLOVER, TIMOTHY, WHEAT BRAN, AND CORN [1]

Feeds	Total dry matter	Digestible protein	Digestible carbohydrates	Digestible fat
Alfalfa hay	91.6	11.0	39.6	1.2
Red clover hay	84.7	6.8	35.8	1.7
Cowpea hay	89.3	10.8	38.6	1.1
Timothy hay	86.8	2.8	43.4	1.4
Wheat bran	87.7	12.3	37.1	2.6
Cotton seed meal	91.8	37.2	16.9	12.2
Corn (grain)	89.4	7.8	66.7	4.3

[1]Compiled from Henry's "Feeds and Feeding"



Fig. 2. A fully developed alfalfa plant. Grown in Jasper county

SOILS FOR ALFALFA

Many people make the fatal mistake of expecting alfalfa to do well on soils that are not fit properly to produce any kind of a crop. There is just as much need of care in selecting and preparing soils for alfalfa as for any other crop and probably more, because of its deep rooting habits and large plant food requirements.

Deep, loamy soils with open subsoils are undoubtedly best for alfalfa, but there is plenty of evidence to show that it may be successfully produced on almost any type of soil, from light sandy

or gravelly loams and peats or mucks to heavy clays, provided that it is well drained, sweet, and properly supplied with organic matter and available plant food. In 348 trials conducted by this station in recent years in cooperation with farmers throughout the State, 68 out of 83 clays, 167 out of 188 loams, and 69 out of 77 sandy soils gave satisfactory results. Failures seemed to be due to factors other than the type of soil.

Many soils that at present are not fit for alfalfa culture may be made so by providing drainage facilities, correcting acidity, adding organic matter, or supplying needed plant food, according to the requirements. *Good drainage is essential in order that the roots may go deep into the soil.* Hardpan must be broken up or avoided altogether. Soils that are sour may be made sweet by thorough drainage and the application of lime. *A good supply of decomposable organic matter in the soil helps the bacterial action in making plant food available, facilitates the inoculating process, and together with good drainage prevents heaving in the spring.* For soils that are out of condition in this respect, a good way to supply organic matter if sufficient manure is not available is to raise and plow under a crop of cowpeas or some other green manuring crop before attempting to grow alfalfa.

Peat and muck soils may be used for alfalfa if they are well drained and properly supplied with mineral plant food. Potash is nearly always lacking in these soils and often phosphoric acid and lime must also be supplied. Soils that are subject to flooding are not good for alfalfa.

It is strongly recommended that the beginner in alfalfa culture put the crop on a piece of his best land. He can experiment with it later when he knows more about it.

SOIL FERTILIZATION

Alfalfa requires large quantities of plant food and cannot be expected to do well on poor soils. Its deep rooting habits may enable it to extract more food from the soil than most other crops, but to secure large yields there must be an abundance of food within easy reach and if the soil is not naturally well supplied, manure or commercial fertilizer must be added. After it is thoroughly established and properly inoculated with its nitrogen gathering bacteria, alfalfa will supply itself with nitrogen from the air, but all potash, phosphoric acid, and other mineral food must come from the soil and as the crop is naturally a large producer, large quantities are required. Of the plant food that must come from the soil, potash and phosphoric acid are most largely required and

these are the two substances in which the soil is most likely to be deficient. Every ton of alfalfa hay which is removed from the land takes with it about 11 pounds of phosphoric acid and 40 pounds of potash.

Every alfalfa field should be started with a liberal dressing of stable manure, if possible. Experiments have proven time and again that manure is unusually valuable in starting alfalfa. It not only supplies plant food but also improves the physical condition of the soil and facilitates the inoculating process. In many of the experiments conducted by this station, special inoculation of the soil was found unnecessary when plenty of manure was applied.

When sufficient manure is not available and the soil is not already rich and well supplied with organic matter, a crop of cowpeas or some other green manuring crop should be grown and plowed under and a high grade commercial fertilizer applied. Just what kind of a fertilizer will be required will depend upon the character and condition of the soil. In most instances, however, it will be well to use a fertilizer rich in both phosphoric acid and potash. A mixture containing perhaps a little nitrogen, and eight to 10 per cent. of phosphoric acid and the same of potash, applied at the rate of three or four hundred pounds per acre will be sufficient unless the soil is quite poor, in which case heavier applications may be profitable. The fertilizer should be disked into the ground some time in advance of seeding.

LIMING SOILS FOR ALFALFA

To what extent Indiana soils are in need of liming in order to produce alfalfa successfully is not definitely known. It is known, however, that alfalfa will not thrive in soils that are sour and that there are many such in the State. In some of the experiments conducted during the last few years, liming has been found to increase the yield of alfalfa, while in other cases the lime produced no apparent effect.

Soils that produce good crops of clover will probably not be seriously in need of liming for alfalfa. On the other hand, where there is trouble in getting a stand of clover, or where this crop does not otherwise succeed well, it will usually pay to lime the soil, and liming may be actually necessary before alfalfa will do well, because the alfalfa bacteria will not thrive in acid soils.

In the case of soils that are sour because of lack of drainage, liming alone will not be sufficient. Drainage must receive first attention. The soil must also be otherwise put into good physical condition by proper tillage methods, the addition of organic matter, etc. After these things have been attended to, if the soil is in need of lime this substance can do its work properly.

The most satisfactory method of determining whether or not a soil is in need of liming is to make a small trial application of lime on a patch sown with alfalfa some time before seeding the whole field. Such an experiment may result in saving the expense of liming and is well worth making where there is serious doubt, because in many instances there is a sufficient natural supply of lime in the soil. In some portions of the State where there is an abundance of limestone, the soils may, nevertheless, respond to applications of lime because they bear no direct relation to the rock upon which they rest.



Fig. 3. A convenient method of distributing ground limestone

Where liming is necessary, an application of ground limestone will usually be most economical, although other forms of lime will give equally good results. The amount that should be applied will depend upon the needs of the soil, but probably not less than two tons of ground limestone per acre should be used, and double this amount may be necessary to secure the best results. It may be applied at any time, but the longer before sowing the alfalfa the better. It is a good plan to begin preparing the ground for alfalfa a year or so in advance and in that case the lime may be applied when preparing the soil for the preceding crop. If the ground for alfalfa is to be plowed in the fall, the lime may be applied at that time. In spring preparation, the lime should be applied immediately after plowing and disked into the soil so as to give it as much time as possible to act before seeding.

INOCULATION

Alfalfa, like all other legumes, requires for its proper development certain species of bacteria which work upon its roots and gather nitrogen for it from the atmosphere. If these bacteria are

not present, the alfalfa will have to depend for its nitrogen upon the supply in the soil which is usually not sufficient to insure a thrifty growth. To get the most out of the alfalfa crop and, in fact, before it can make its best development, the roots must be inoculated with the proper nodule forming, nitrogen gathering bacteria. *In the majority of cases where alfalfa is sown for the first time, it will need to be inoculated by some artificial means.* The



Fig. 4. Young alfalfa roots showing the characteristic nodules of the nitrogen gathering bacteria

surest and most practical way to do this is to broadcast and harrow in, before sowing the seed, some earth from a good alfalfa field where the bacteria are known to exist. At least two or three hundred pounds of soil per acre should be used. In securing this soil, care should be taken to secure it from a clean, healthy field so as to avoid the introduction of weed seeds or plant diseases. Care must be exercised, also, to guard against exposing the soil for inoculating to sunlight for too long a time before sowing and harrowing it in, as such exposure is detrimental to the bacteria. Inocula-

tion may also be effected by mixing and drilling in with the alfalfa seed a small quantity of soil rich in bacteria, but the success of this method is not fully established.

When soil from an old alfalfa field is not available, soil from a place where sweet clover is growing may be used for inoculating. In this case the surface should be first scraped off to avoid transferring sweet clover seed. The use of pure cultures of alfalfa bacteria has not been generally satisfactory, and probably because, with present methods, the bacteria are either dead before they reach the farmer or he is not sufficiently careful in their application. Some farmers are successfully inoculating their soil for alfalfa by sowing some alfalfa seed with clover a year or two before sowing alfalfa alone. Where there is any doubt, the safest plan is to inoculate.

THE TIME TO SOW ALFALFA

If the weather conditions are favorable and the soil is in good condition and free from weed seeds, it does not seem to make any important difference when the seed is sown so long as there is sufficient time for the young plants to establish themselves thoroughly before winter, and good results may be secured at any time from April to August. Trouble with weeds is most likely to arise with the earlier seeding, while with the later seeding there is liable to be an insufficient supply of moisture in the soil to permit of proper soil preparation, and the germination of the seed and the development of the plants may be seriously delayed by periods of drought. In the Experiment Station's trials with late summer seeding during the last six years, periods of drought have been occasionally encountered in different parts of the State, which have more or less seriously interfered with getting a satisfactory stand or a sufficient amount of growth before winter. To insure success, therefore, it seems wisest not to delay seeding beyond the first of August in the northern counties and the fifteenth of August in the southern portion of the State. Seedings made in April or May, on the other hand, are so liable to be troubled with weeds that such early seeding is not advisable, even with the use of a nurse crop, unless the ground is known to be free of weed seeds. On this point we would especially caution farmers, as few realize how full of weed seeds the soil really is.

KILLING WEEDS

Trouble with weeds has caused more alfalfa failures than any other one thing. On account of the danger of trouble with weeds in spring seeding and the liability of interference by drought in late

summer seeding, it is undoubtedly safest and best, where it can be done, to spend the spring in ridding the ground of weed seeds and then sow the alfalfa alone about the end of June or the early part of July. In this case the ground should be plowed in the spring, turning under some manure, if possible, and then harrowed every 10 days or two weeks until seeding time. Each successive harrowing will kill the weeds that have started and put a fresh lot of seeds in a position to germinate until, finally, all weed seeds near enough to the surface to grow will have been destroyed.

PRECEDING CROP

What the preceding crop is does not seem to be important so long as it will permit of thorough soil preparation for the alfalfa. A corn crop which can be given clean culture will usually be best, though for summer seeding any spring sown crop which can be removed early in the summer may be used. Early potatoes, peas for canning, clover and small grain crops can all be used to precede summer sowing.

PREPARING THE SEED BED

Preparation of the soil for alfalfa should usually be begun with the preceding crop, applying any needed lime at that time. In any case, a fine, mellow seed bed with a firm sub-surface should be prepared and weed seeds killed by repeated harrowing, as directed in preceding paragraphs. Extra deep plowing is not advisable. The plowing should be done as long as possible before seeding so that the soil may become thoroughly settled and firm before seeding. Disking before spring or summer plowing will help to make a good seed bed. Where alfalfa is to follow peas or early potatoes, a good seed bed can usually be prepared without plowing.

THE NURSE CROP

Whether or not alfalfa should be sown with a nurse crop has been a much discussed question. The experiments of this station and the experience of many farmers in the State have shown that a nurse crop is not necessary. Of 269 successful alfalfa growers answering the question "Is a nurse crop necessary?" 196 or 72.8 per cent. replied "No," while 73 or 27.2 per cent. favored the nurse crop. Where the nurse crop was favored, spring seeding was most commonly practiced.

Generally speaking, there is no good reason for spring seeding alfalfa since it will seldom make a satisfactory hay crop the first

season, and all that is needed is a sufficient growth to establish the plants thoroughly and enable them to pass successfully through the winter, and summer seeding will seldom fail to do this. The danger of trouble with weeds is altogether against spring seeding.

When spring seeding is favored, a nurse crop will help to keep down weeds. A half seeding of oats or barley should be used and this should be cut for hay soon after heading so as to give the alfalfa full possession of the ground before hot weather begins. Summer seedings do not require a nurse crop.

METHOD AND RATE OF SEEDING

Probably the best method of sowing alfalfa seed is with a drill, as by this means it may be covered most uniformly. When a nurse crop is sown with it, as in the case of spring seeding, the alfalfa seed should be put into the grass seed attachment and dropped ahead of the drill shoes. In the case of summer seeding, without a nurse crop, drilling the same as wheat, with the drill set to run as shallow as possible, will usually be best. With some drills the hoes of the grass seed attachment may be turned into the grain hoes. Where this cannot be done, the wheat cups may be used and the alfalfa seed mixed with enough coarse corn meal to increase the quantity so that the drill will handle it properly. When drilling is not convenient, the seed may be sown broadcast and lightly covered with a harrow.

The rate of seeding should be about 20 pounds per acre, although with favorable conditions 15 pounds of good seed will be sufficient.

CLIPPING YOUNG ALFALFA

The information we have concerning the clipping of alfalfa during the first season is too contradictory to permit of formulating any general rule. It seems, however, that clipping has sometimes been overdone and that young alfalfa should rather be allowed to grow undisturbed so long as it is doing well and does not bloom. In the case of early seeding, one clipping late in the summer will usually be sufficient. Generally speaking, clipping should be practiced only when the growth seems checked, or the tops of the plants turn yellow. If not too heavy, the cut material should be left on the ground to act as a mulch. In the case of late summer seeding, all growth should generally be allowed to die down naturally for protection over winter.

THE TIME TO CUT ALFALFA FOR HAY

When alfalfa is used for hay it should be cut whenever the new shoots at the crowns of the plants are well started. This is a better guide to the proper time for cutting than is the appearance of blossoms. The base of the plant should be carefully examined. The new growth appears in the form of buds at the base of the old stalks. The new shoots should have a start of half an inch to an inch before the old growth is cut. In the investigation carried on during the past year several farmers stated that they had killed their alfalfa by cutting too soon. On the other hand, it has been observed that nothing is gained by letting it stand after growth has been checked, no matter what the cause may be. Whenever the tops turn yellow, or the crop becomes seriously affected by leaf spot or other disease it should also be cut, even though the fresh shoots have not started.



1 Sown July 30, 1907 Yield of hay, 285 lbs. | 2 Sown Aug. 10, 1907 Yield of hay, 315 lbs. | 3 Sown Aug. 24, 1907 Yield of hay, 135 lbs. | 4 Sown Sept. 12, 1907 Yield of hay, 11 lbs.

Fig. 5. Showing the yields of alfalfa cut June 2, 1908, from equal sized plats sown at different times during the summer of 1907, as shown above. Each plat is represented by two cocks of hay

MAKING ALFALFA HAY

About the best practice in making alfalfa hay is to mow in the afternoon. The next morning, as soon as the dew is off, the field should be gone over with a tedder. In the afternoon it may be raked and put up in small cocks where it should be allowed to cure for a few days before hauling to the barn.

Care must be exercised to avoid loss of the leaves. The leaves are fine and easily lost and should never be allowed to become dry and brittle before raking up.

A side-delivery rake is a good implement for taking up the hay and where such is used a tedder is not necessary.

Where much alfalfa hay is made, it will pay well to use canvas shock covers to protect the cocks from rain.

PASTURING

Alfalfa should never be pastured the first season, and in most cases it will be best to use it for hay-making during the second season also, in order that it may become thoroughly established before animals are allowed to trample over it. It should never be pastured closely, as this injures the crowns of the plants. Horses and sheep are more likely to do damage in this way than are cattle or hogs. Alfalfa pasture is especially good for hogs during hot weather. With cattle and sheep, care must be exercised to avoid bloating. At first the animals should be turned in for only a short time each day, and when the alfalfa is wet with dew or rain there is still greater need of care to avoid bloating. It is wise to be a little more careful than with clover.



Fig. 6. A good alfalfa field, Madison county, Indiana

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 37

LaFayette, Ind., April, 1912

HOUSING FARM POULTRY

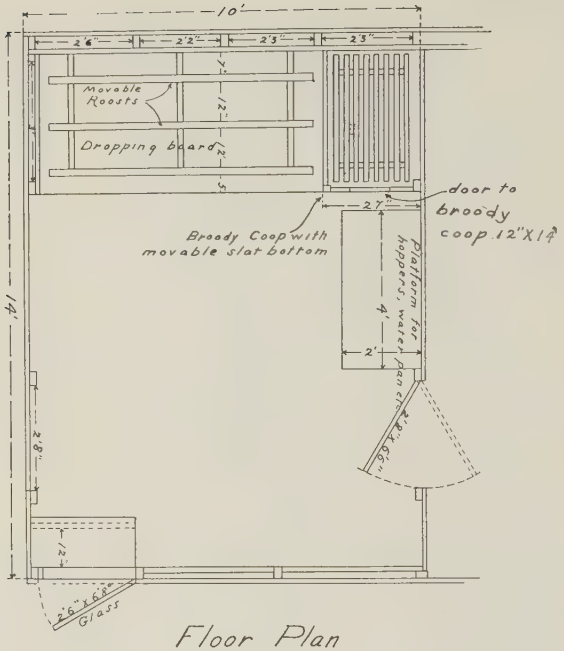
A. G. Philips

Division of Poultry, Department of Animal Husbandry

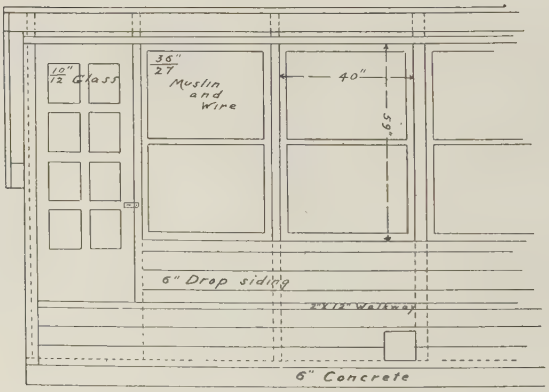


Fig. 1. Open front poultry house. The poultry house is the home of the hen

Good housing is one of the essentials for egg production and consequently should be given proper consideration. A hen that is comfortable and happy is more apt to be profitable than one that is uncomfortable.



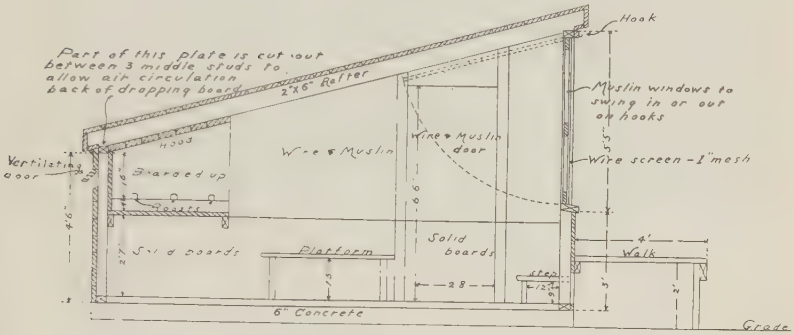
Floor Plan



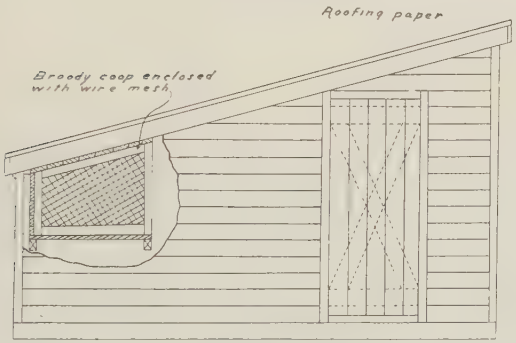
Front Elevation

Fig. 2. Open front poultry house

(Continuation of plans on page 2)



Cross Section



Side Elevation

Fig. 3. Open front poultry house

Working plan of a 10 x 14 pen for either a single or continuous house. Such a house has proven satisfactory at the Purdue Experiment Station. Illustration of this house is found on page 4.



Fig. 4. The Purdue Experiment Station poultry farm

Note the growing crops on the land in the yards. One year old fruit trees are growing between the sets of corn rows. This system allows natural conditions for the fowls, and so egg production, fertility and hatchability are increased. By using orchards and cultivated fields no land need be especially set aside for poultry. Growing corn furnishes splendid shade.



Fig. 5. Continuous house with small yards

An undesirable method of yarding, because the range for the fowls is restricted, soil contamination increased and labor more expensive.

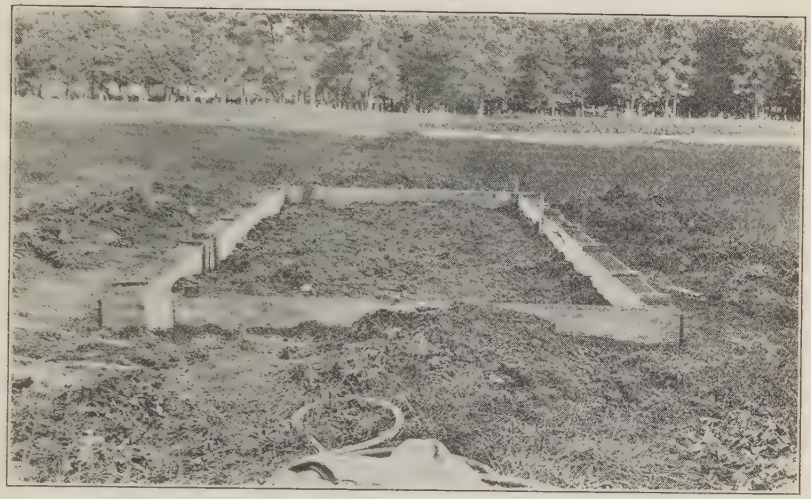


Fig. 6. Foundation of a poultry house

A good foundation is the first essential of a poultry house because it is rat, cold air, and water proof. For an ordinary house, a foundation 4 inches wide, 6 inches above and 12 inches to 16 inches below ground is satisfactory. The cut shows a board form filled with a 1 to 6 mixture of concrete. If the ground does not slope correctly or if the soil is very heavy, it sometimes is desirable to run a tile drain around the foundation to carry away any surplus water. Grade up around the foundation in order to drain the water away from the house.

When a foundation has been properly constructed, a good concrete floor should be put in. Fill the area inside of walls of foundation with gravel, cinders, etc., to within two inches of top, dampen and tamp it well. Put on top of this a 1 to 6 mixture of concrete. This floor will then have the contact with the soil broken, and hence always be dry. A concrete floor is cheaper to build than a board floor and far more sanitary. The front of the house should face the south and be on sloping, well drained land.

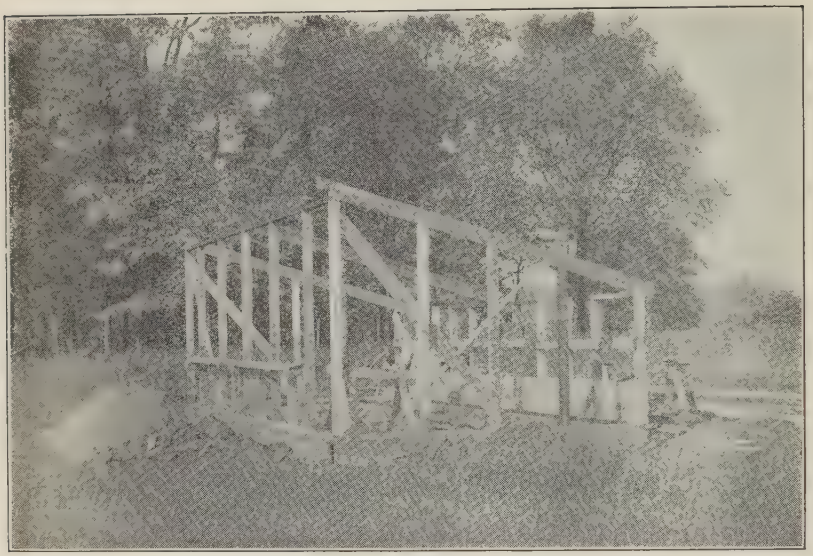


Fig. 7. Framework of poultry house showing construction

The materials used in a poultry house need not be expensive. Studding made of 2 x 4 yellow pine and rafters of 2 x 6 yellow pine will be of sufficient strength to hold any weight put upon them. As long as the walls, roof and floor of a house are tight, the principles of construction are correct. The materials used in making these tight, can be cheaply purchased. Sides made of drop siding will be tight, and a roof covered with 6 inch flooring or shiplap, on top of which is placed two-ply roofing paper, will be air and water tight and last for years. A shingle roof is not a satisfactory roof, for it is not air tight. A shed roof house is the most satisfactory where a house is to be only 14 to 15 feet deep. It is easier and cheaper to construct and allows plenty of sunshine to enter. Deep houses are warmer than shallow ones, and for that reason many practical poultrymen are building houses 20 to 24 feet deep.

A house 14 to 15 feet deep is the best, on the average farm, allowing 4 to 5 square feet of floor space per fowl. The front should be high enough to allow sunlight to reach the back of the house, seven or eight feet usually being high enough for such a depth. The rear need be no higher than necessary, four and one-half feet being generally found satisfactory.

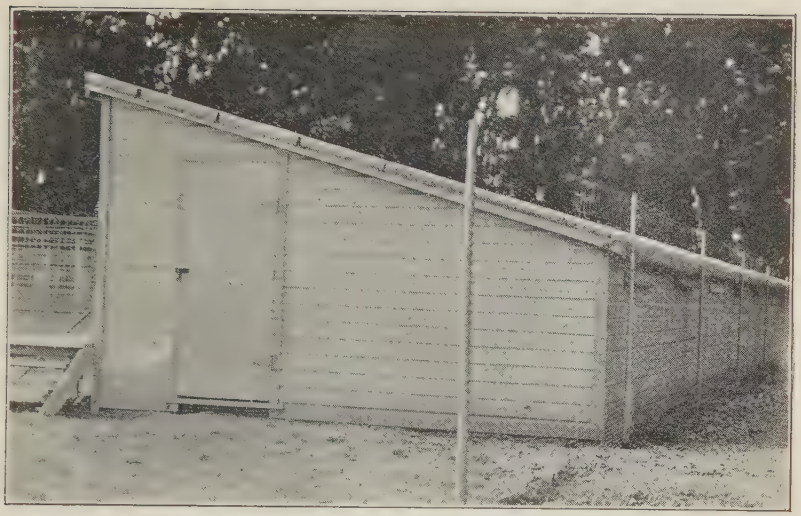


Fig. 8. Back of poultry house showing ventilator, wall construction and roofing materials

The ventilation of a poultry house is very important. A house with tight walls, roof and floor and an open front, will contain cold, dry, and pure air, three essentials for the health of the fowls in winter. With such a construction there will be no draughts, but plenty of fresh air. Cloth curtains on the front openings can be dropped on cold nights or during stormy weather, and a glass window will allow entrance of light at all times. Many cases of colds have been cured by removing the south side of the house and allowing sunshine and cold, pure air to enter. Hens must not freeze, neither do they need to be kept too warm.

In the summer time a ventilator in the back of the house is opened. Air enters this and goes up between the studding and rafters through the hood, above the heads of the fowls. This allows circulation of air, thereby allowing the warm air to escape, in the summer, without a draught on the chickens' heads. To allow for this air passage the back plate is cut out between three studding. See illustrations on pages 6 and 8.

It is not advisable to use ventilator shafts or other devices to insure ventilation. In fact many houses that have proved satisfactory in every way have no ventilating schemes whatever, nor any roosting hood.



Fig. 9. Interior of poultry house showing raised roosts, and trap nests on wall

If nests are not placed under dropping boards, but are placed on the wall, they should be so constructed as to prevent hens roosting in them. Note hood in roosting quarter.

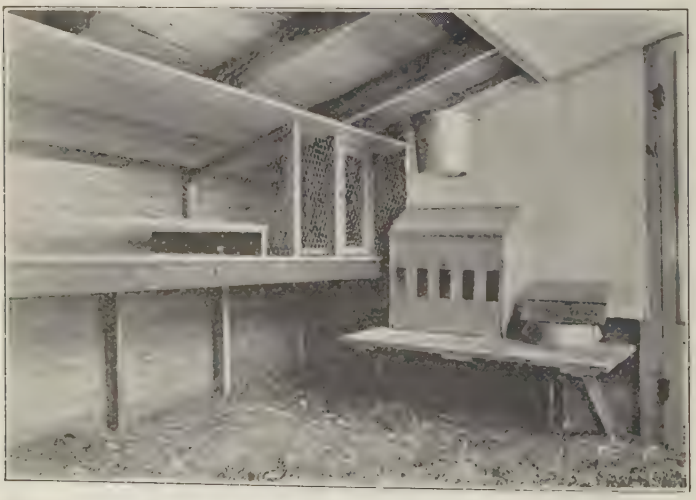


Fig. 10. Interior of poultry house showing platform on which are placed all feed and drinking vessels

This keeps everything up off the floor, insures cleanliness and prevents wasting.



Fig. 11. Interior of continuous house

Note cloth and wire partitions used in winter to prevent circulation of air or draught. Also note platform supporting grit and feed hopper and water vessel. In this illustration the front curtains are closed. Note sunshine coming through windows at noon when curtains are closed.



Fig. 12. A type of house too common on Indiana farms

This house is too high in front, full of cracks, very dark, has no foundation or floor and hence is damp and unhealthy. Even a window would have made an improvement in this house.



Fig. 13. Purdue students building different types of poultry houses

It is not necessary to be an expert carpenter to build a poultry house. These students are building four types of houses in order to find the most practical kind.

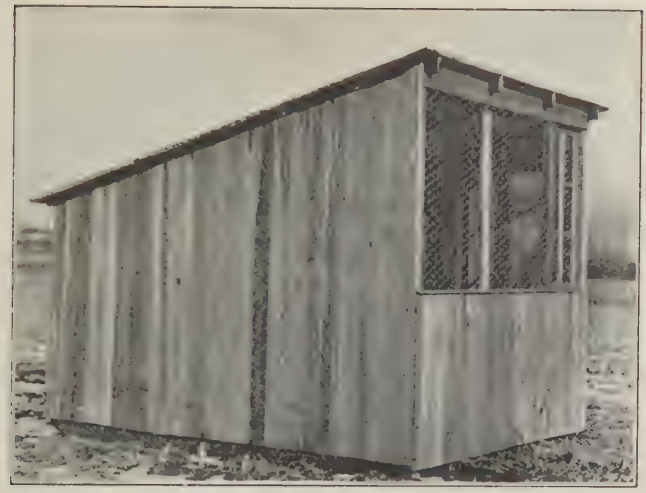


Fig. 14. Portable colony house. A house sided with flooring laid perpendicularly

This method of construction reduces the number of necessary studding.



Fig. 15. Colony breeding house. A house sided with box boards—the cracks covered with battens

This is a common form of barn construction, but is not tight enough for a poultry house. The cracks will allow draughts to be formed.

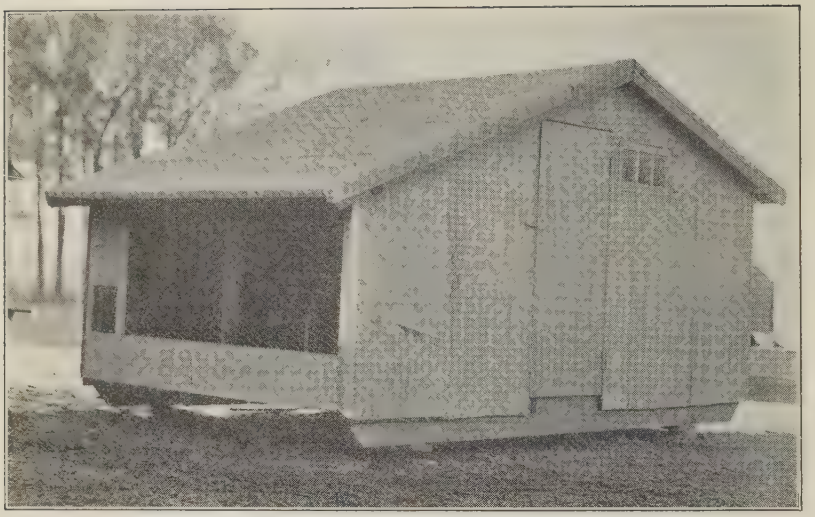


Fig. 16. Tolman colony house

This is a type of house rapidly coming into prominence in the middle west as a most satisfactory house. It has the advantage of reducing the air space, and also the lumber bill, besides always allowing plenty of fresh air. At Purdue this house is not light enough inside, and the hens all stay towards the front, not using the back half to any extent. In severe winter weather a curtain should be dropped over the opening, or the birds will freeze badly. In the summer some means of shade must be available for it becomes very hot and close inside. Placing this house on runners helps out the shade problem.

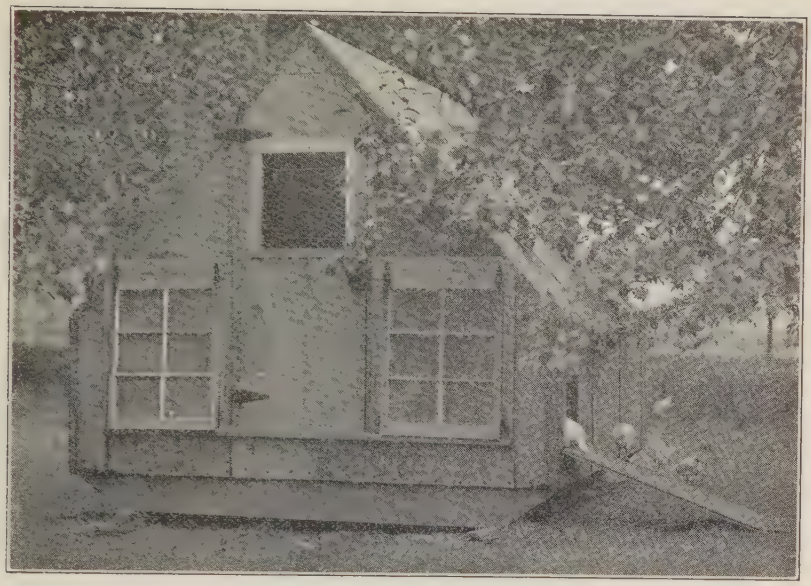


Fig. 17. A portable "A" shaped colony house

This is a type of house used at the Experiment Station as a brooder for 200 chicks in the spring, as a colony house during the summer, and a laying house during the fall and winter. It is placed on runners, and is easily moved. A colony brooder is the only type that can be used the year round, thus overcoming the common practice of having idle brooders eight months of the year.

This particular type of "A" shaped brooder is heated with gasoline, the hover and heating apparatus having been designed at Cornell University.

The Colony brooder is the cheapest brooder that can be built, saves much labor, and if heated by gasoline is the only brooder that supplies fresh air directly under the hover. The house can be moved from place to place and roosts put in when the hover is removed. This house is 8 x 8 feet square and 6½ feet high from floor to comb. It is not economical to use this size colony brooder where less than 150 chicks are brooded at once.

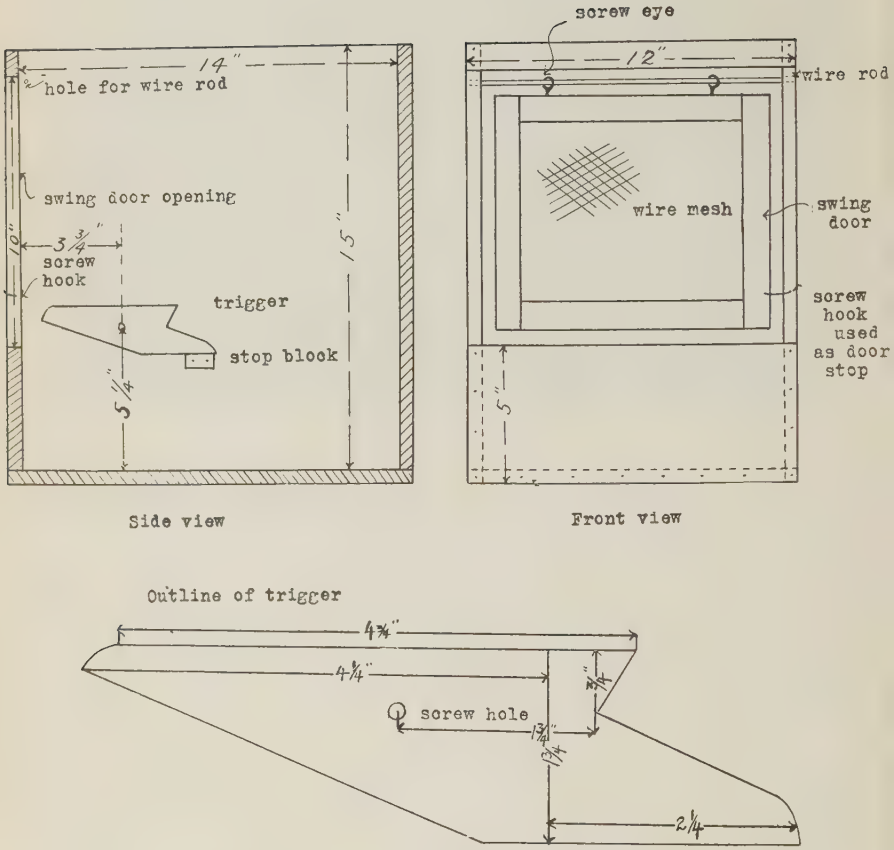
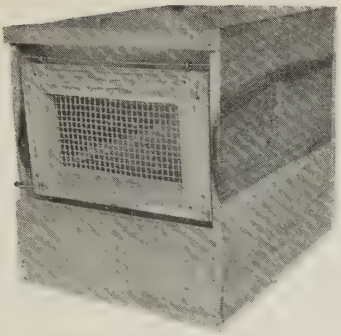
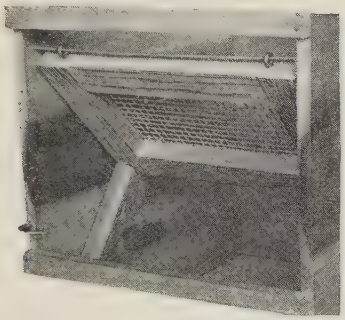


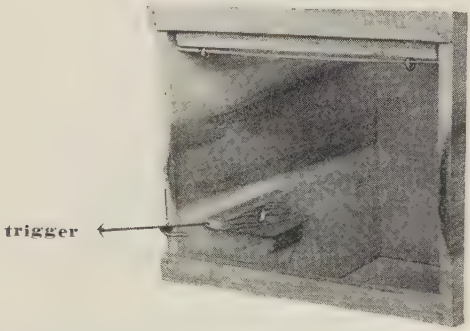
Fig. 18. Connecticut trap nest—working plan



Door closed



Door opened showing position of trigger when trap nest is set



Door removed to show position of trigger when door is closed

Fig. 19. Connecticut trap nest

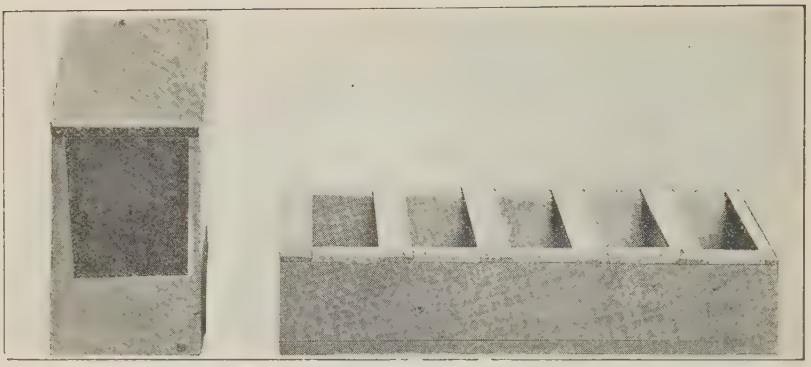


Fig. 20. Grit and feed hopper

To prevent waste of feed and reduce the labor of handling the dry mash, it is necessary to use hoppers. These two hoppers are cheap and easy of construction, and are being used satisfactorily on the Purdue farm. They are not rat proof. The grit hopper can be made longer and used as a dry mash hopper. The dry mash hopper should have a lid to use when it becomes necessary to shut off food supply.

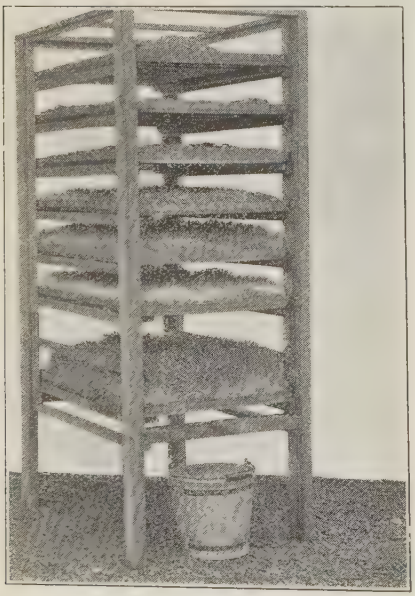


Fig. 21. Oats sprouter

Green food is essential as a part of the winter ration. When cabbage and beets are not available, sprouted oats can be easily fed. Soak the oats in a bucket for at least 24 hours and then place in a pile on top shelf of a sprouter. On the third day spread them out and let them grow to a height of not over two inches, then feed them. Keep the oats in a room of moderate temperature and dampen every day.

Acknowledgements for valuable assistance on this circular are due:

Mr. J. E. Dougherty, Poultry Department, Purdue, for the drawings.

Mr. J. C. Allen, Animal Husbandry Department, Purdue, for the photographic work.

PURDUE UNIVERSITY
Agricultural Experiment Station

Circular No. 38

LaFayette, Ind., January, 1913

AGRICULTURAL EXTENSION
XVII

INDUSTRIAL CLUBS AND CONTESTS

Industrial clubs and contests are receiving much attention in Indiana and are playing an important part in the furtherance of agriculture and industrial education. Through the clubs and contests many lines of work are being advanced and progressive principles are being applied. Lessons are learned from actual experience and a knowledge is gained which will mean much to the individual in the laying of a splendid foundation for a useful life. A desirable atmosphere about labor is created; it is known as the means to acquire dignity through achievement and not as a burden from which one should shrink. The recognized advantages of contests are many and are worthy of consideration.

The contest demands the actual doing of things, and thereby interests many in its individual importance. It is splendid for the youth to hear or to read of things being done by someone else. From this they may gain much of interest and value. However, when one performs a task for himself, putting into it his best thought and effort, the results are bound to be of the greatest value in the knowledge and the personal satisfaction gained, and in the lasting respect for labor acquired.

Contests develop a spirit of loyalty among the people of any community. The football, baseball or basketball game makes the community, school or college a unit for the support of its team. In like manner, the educational contest brings the people of all sections of township, county, state or nation to the support of the movement, and gives to these people a deeper appreciation of the merits of the parties engaged in the various lines of activity.



Fig. 1. An Indiana corn club—Hamilton county

What community has not felt the influence of an educational contest of some nature? An oratorical contest may arouse a civic loyalty merely through the fact that the community is represented by an able resident, in competition with representatives of other communities. The agricultural contest in the rural districts has the same logical outcome. The interest of entire communities is suddenly and permanently affected. Every effort is extended and support given by all to produce the best possible results from the material in hand.

Contests do much to broaden the knowledge and viewpoint of contestants. The boy who takes part in a corn contest is developing a nucleus of good citizenship. He is not alone content with the planting, cultivating and harvesting of the crop, but secures and studies all possible literature regarding corn growing; he sees the vast possibilities of his plot of ground under ideal conditions; he endeavors to attain these conditions by studying the "leaks" in corn growing methods, and strives to overcome them. He learns the requirements of the ideal seed ear and practices corn scoring. He not only tries to grow a large number of bushels of corn, but he also tries to become more proficient in the work, and to extend his knowledge of the various phases of corn growing. The knowledge attained is given a practical application and the boy is taught the value of his individual research in such a way that he does not fail to follow the same methods in other lines of endeavor.

Contests assist in improving methods of doing things, and in securing greater efficiency. Through corn growing contests it has been found that more than two hundred twenty-seven bushels of corn can be grown on an acre of ground. Without the improvement of the ordinary methods of corn growing this could never have been accomplished.

Through contests some farmers have had their attention called to the fact that they were producing eggs during winter at a cost of about forty cents per dozen. The results of the contests in the neighborhood showed that the cost of producing eggs at that time, under the existing conditions, should not have exceeded eight cents per dozen. As a result of this work, action on the part of the people has been stimulated and an attempt is being made, not only to grow more corn per acre and to produce eggs at a lower cost, but to improve all forms of agricultural practice. Similarly improved methods in house work and other lines are being developed.

ORGANIZATION

In organizing clubs and contests it is necessary to consider factors that will bring about the desired results and at the same time

give permanency to the organization. That is, the club or contest should be affiliated with some recognized organization that perpetuates itself from year to year.

From a study of Indiana conditions it is believed that the county farmers' institute in cooperation with the county superintendent of schools and his forces made a desirable organization for the conducting of clubs and contests.

The farmers' institute is a thoroughly organized agricultural body and has for its chief object the betterment of conditions of the agricultural people. This organization also has authority, by an act of the state legislature, to engage in this line of work and to use a portion of its funds for premiums for agricultural contests.

The county superintendent of schools should be interested in this movement and he should give it his hearty support, since the clubs and contests assist him in training boys and girls. They bring the teachers and pupils closer together and are of great value in rallying the parents to the support of the schools. He is necessary in the organization, for by his office he is in direct touch with the boys and girls. Through his teachers he is able to enlist the pupils in the club and contest work. Also through his office, a large amount of executive work can be done, and by him, cooperation of the teachers who are necessary to the success of the work, can be secured.

Among these forces work can be divided in a way that it can be made more effective and helpful from every standpoint than if one individual or organization should attempt to carry out all the many details.

STEPS IN ORGANIZATION

The county superintendent of schools is the logical man to lead the work of organizing clubs. Those who desire to organize clubs should communicate with him, or with the Agricultural Extension Department, Purdue University, Lafayette, Indiana. This department will gladly furnish enrollment blanks, printed matter dealing with the special line of work to be taken up by the club, and will assist in every way possible in organizing clubs for active work.

Should a teacher write to the Extension Department for assistance, enrollment blanks would be sent, and the county superintendent of schools would be informed of the movement and be requested to cooperate. After the enrollment blanks have been secured, the teacher should at once enroll the pupils who wish to join the club. While it is not advisable to undertake too many different lines of work, yet in some schools there might be corn, apple, and potato clubs for boys, and vegetable growing and can-

ning, sewing, and baking clubs for girls. One line of work for boys, and one for girls is enough in most cases.

Should a business man, or any person not connected with the schools, want to organize a club, the county superintendent of schools, or the Extension Department, should be notified. Through these agencies the boys and girls would be reached.

If the county superintendent of schools takes the initiative in the work of organization, he can send to his teachers a letter and outlines of the work contemplated, explaining the objects of the contests and why the boys and girls should join, and asking the teachers in turn to explain this to the pupils, and to enroll those who will join.

Suggested form of letter to be sent to school teachers of the county:

Dear Teacher:

An effort is being made in this county to organize industrial contests for boys and girls of the schools. The enclosed outlines will give you some idea of the work contemplated.

Through these contests it will be possible to interest the boys and girls in the work of the farm and the home and at the same time create greater interest in the school work. For this reason, we ask you to cooperate in this movement and assist us in interesting the boys and girls together with their parents in these contests.

Kindly explain the purpose of the contest to your pupils and have all those who will agree to undertake the work, sign the attached pledge which should be returned to this office at once.

Thanking you for your interest and cooperation, I am

Very truly yours,

County Superintendent

Pledge:

We, the undersigned, agree to join the..... County Boys' (or Girls') Club and to take an active part in the contests to be conducted this year.

Name..... Age.....

R. F. D..... Postoffice.....

Township

Parent or Guardian.....

Members of the clubs should keep in close touch with the Purdue Agricultural College, and the United States Department of Agriculture. In order to insure this desired relationship, a list of the members of all clubs should be sent to the Purdue Agricultural Extension Department. Blanks for this purpose should be secured from the Extension Department.

Not later than the first of April a meeting of club members and others interested in the contest should be held at some central point. The object and details of the contest should be presented and full instructions given for carrying on the work. Some popular speaker should be present to arouse interest and enthusiasm. In this way all are started with a clear understanding of what is expected of them, and the interest in the work will be greater.



Fig. 2. Shelling and preparing the seed corn for corn club

BOYS' CORN CLUB

Rules

1. All contestants shall be between 10 and 18 years of age.
2. Each contestant shall agree to make a special study of scoring, selecting, planting, cultivating, and harvesting corn.
3. Each contestant shall grow an acre or more of corn each year. (The size of the plot may be less than an acre.)
4. Each boy shall plant, cultivate, and harvest his own corn. However, if necessary, he may have assistance in breaking and bedding his land, and in harvesting his crop.
5. Each contestant shall keep a record of the details concerning his plot, work done, and the number of bushels harvested.
6. Each contestant shall write an account of not over four hundred words of how he made his crop.
7. Each boy shall select 10 ears grown on his plot and exhibit them at the annual corn show of the club.
8. In estimating profits, $5.00 per acre shall be charged as rent of land. The work of each boy shall be estimated at 10 cents per hour, and the work of each horse at 5 cents per hour. Manure shall be charged at the rate of $1.00 for each one-horse wagon load, and $2.00 for each two-horse wagon load.
9. Each member shall take an active part in the meetings of the club when requested, shall read all instructions of demonstration work, and shall do everything he can toward making the club a success.
10. In awarding premiums the following basis shall be used:
 (a) Greatest yield per acre..... 30 points
 (b) Best exhibit of 10 ears..... 20 points
 (c) Best written account of crop..... 20 points
 (d) Best showing of profit on investment..... 30 points

 Total 100 points

Contestant's Record Blank

A detailed record should be kept of the plot, dates of planting, cultivating, harvesting, etc., and the crop.

Record of Corn Plot

(To be filled out by each contestant.)

1. Contestant's name
 P. O. Address.....Rural Route.....
2. Variety of corn planted.....

3. Source of seed.....
4. Method of handling seed from time of gathering the previous fall to planting time.....
5. Vitality of seed:
 How tested
 Per cent. of germination.....
6. Plot:
 Length in feet.....Width in feet.....
 Area in sq. ft.....Kind of soil.....
 Kind of subsoil.....
7. History of plot:
 Crops grown there for three years previous to time of planting. 1907..... 1908..... 1909.....
8. Fertilizers applied during three years previous to time of planting. 1907..... 1908..... 1909.....
 Kind
 Amount
9. Fertilizers used in 1910:
 Kind
 Amount
10. Preparation of seed bed:
 Date of plowing.....
 Cultivation

Implements	Time used
.....	
.....	
.....	
.....	

11. Date of planting.....
12. Name of planter used.....
13. Distance between rows
14. Distance between stalks in rows if drilled.....
15. Number of kernels per hill planted.....
16. Cultivation:

Number	Date	Depth	Reason
1.			
2.			
3.			
4.			

17. Kind of cultivator used.....

Harvest Time

18. Number of stalks in plot:
 - Barren
 - Smutted
 - Suckered
 - Two-eared
19. Stand of corn in plot:
 - Average number of stalks per hill.....
20. Date the corn matures:
 - Roasting ear
 - Dented or glazed
 - Ripe
21. Height of corn (measure 10 average plants and take the average).....feet.....inches.
22. Total number of leaves on 10 plants each taken from different hills
23. Yield:
 - Bushels on plot
 - Bushels per acre
24. Cost of producing corn:
 - Value labor of boy at 12 cts. per hr.
 - Value team and boy at 25 cts. per hr.
 - Cost of plowing.....hrs. @ per hr.
 - Cost of preparing seed bed.....hrs. @ per hr.
 - Cost of manure or fertilizer
 - Cost of seed
 - Cost of planting hrs. @ per hr.
 - Cost of cultivation:
 - Harrowing hrs. @ per hr.
 - 1st cultivation hrs. @ per hr.
 - 2nd cultivation hrs. @ per hr.
 - 3rd cultivation hrs. @ per hr.
 - 4th cultivation hrs. @ per hr.
 - Hoeing hrs. @ per hr.
 - Other cultivation hrs. @ per hr.
 - Cost of husking corn.....hrs. @ per hr.
 - Cost of harvesting fodder.....hrs. @ per hr.
 - Rental value of land for corn
 - Total cost
 - Yield of plot.....bushels
 - Cost of producing one bushel of corn
 - Cost of producing one acre of corn

Small booklets for the keeping of records can be secured of the Secretary, Indiana Corn Growers' Association, LaFayette, Ind.

CONTESTS FOR GIRLS

It has been deemed advisable to so arrange the contests for girls that their work might cover somewhat the same length of time as that of the boys. These contests might well be in breads, canned fruits, and sewing of various kinds.

The work should be so arranged that small girls shall not be forced to compete with those much older. Girls from 10 to 14 years should be placed in one class and those of 15 to 18 years in a second class.

BREAD CONTEST

Girls 10 to 14 Years

1. Each contestant shall agree to bake at least 25 individual loaves of bread between the first of May and the first of November.
2. Each contestant shall agree to exhibit two loaves of bread at the annual show.
3. Each contestant shall do all the work without any outside help.
4. Each contestant shall keep a record of the details concerning the work done. This shall include a record of the number of loaves baked, kinds of flour used, kinds of yeast, the manner of baking, and the length of time required for each process in bread making.
5. Each contestant shall agree to write an essay of not over 500 words, on the history of bread; bread as made in other countries; what yeast is and how it grows; the manufacture of flour; the difference between hard and soft wheat flour; the quality of a loaf of bread as affected by the wheat and the flour entering into its composition; the recipe used, and the method of procedure in making, baking, cooling, and keeping of bread.

Girls 15 to 18 Years

The contest for girls 15 to 18 years should be the same as that of the first class except that they should agree to bake 50 loaves of bread between the first of May and the first of November, and to prepare a paper of not over 600 words on the subjects in 5.

Note.—These papers should be presented with the bread when entered for prizes

GIRLS' GARDEN AND CANNING CLUB*

1. Each contestant shall agree to raise and can at least 10 varieties of vegetables, chiefly tomatoes. The size of the plot used shall be the same for each member. One tenth of an acre is recommended.

*Girls 10 to 14 years of age should compete in a class to themselves, and girls 15 to 18 years in another class

2. Each contestant shall agree to exhibit at the annual show at least 10 one-pint jars of vegetables, properly labeled, with date, name of vegetable and manner of preservation upon the label.
3. Each contestant shall agree to do all the work without any outside help.
4. Each contestant shall prepare a paper of not more than 400 words, giving reasons why foods are preserved; methods of food preservation, and the reasons for food fermentation and decay.
5. In awarding premiums the following basis shall be used:
 (a) Quality 20 points
 (b) Quantity, total pounds harvested and used.. 20 points
 (c) Variety of canned products 20 points
 (d) Profit on investment 20 points
 (e) Best paper 20 points

 Total 100 points

Contestant's Record Blank

A detailed record should be kept of the plot, date of planting, cultivating, harvesting, canning, etc. Following is a record blank that might be used for tomatoes:

Record of Tomato Plot

(To be filled out by each contestant)

1. Contestant's name
 P. O. Address.....Rural Route.....
2. Variety of tomato grown.....
3. Source of seed
4. Vitality of seed:
 How tested
 Per cent. of germination.....
5. Starting plants:
 Date of sowing seed.....
 Where sown (hotbed, cold frame, open ground).....
 Dates transplanted
6. Plot:
 Length in feet.....Width in feet.....
 Area in sq. ft.....Kind of soil.....
 Kind of subsoil.....
7. History of plot:
 (a) Crops grown there for three years previous to time of planting. 1910..... 1911..... 1912.....

(b) Fertilizers applied during three years previous to time of planting. 1910..... 1911..... 1912.....
Kind
Amount

8. Fertilizers used in 1912:
Kind
Amount

9. Preparation of seed bed:
Date of plowing
Cultivation

Implements	Time used
.....	
.....	
.....	
.....	



Fig. 3. Boys' and girls' club exhibits—Hamilton county

10. Setting:
 - Date
 - Size of plants:
 - Height..... Diameter at stem base.....
 - Machine or hand set.....
 - Weather conditions at time of setting.....
 - Were plants set with soil attached to roots?.....
 - Number reset
 - Per cent. stand at end of season.....
11. Distance between rows
12. Distance between plants
13. Cultivation:

Number	Date	Depth	Reason
1.			
2.			
3.			
4.			

14. Kind of cultivator used.....

Harvest Time

15. Stand of tomato plants in plot.....per cent.
16. Date of first picking.....
17. Date of last picking.....
18. Date of first killing frost.....
19. Yield:
 - Pounds on the plot.....
 - Pounds per acre.....
20. Cost of producing tomatoes:
 - Value labor of boy at 12 cts. per hr.
 - Value team and boy at 25 cts. per hr.
 - Cost of plowing.....hrs. @ per hr.
 - Cost of preparing seed bed.....hrs. @ per hr.
 - Cost of manure or fertilizer
 - Cost of seed
 - Cost of growing plants
 - Cost of planting hrs. @ per hr.
 - Cost of cultivation:
 - Harrowing hrs. @ per hr.
 - 1st cultivation hrs. @ per hr.
 - 2nd cultivation hrs. @ per hr.
 - 3rd cultivation hrs. @ per hr.
 - 4th cultivation hrs. @ per hr.
 - Hoeing hrs. @ per hr.
 - Other cultivation hrs. @ per hr.

Cost of spraying hrs. @ per hr.
Cost of spray chemicals
Cost of harvesting
Rental value of land for tomatoes
Total cost
Yield of plot bushels
Cost of producing one bushel of tomatoes
Cost of producing one acre of tomatoes

SEWING CONTEST

Girls 10 to 14 Years

1. Each girl shall agree to darn one pair of stockings, patch one piece of checked cotton material, and make by hand one gingham apron.
2. The three pieces of work shall be exhibited at the annual show.
3. Each contestant shall agree to do all the work without help.
4. Each contestant shall agree to write a paper on the history, manufacture, selection and care of scissors, thimbles, needles, pins, and thread.*

Girls 15 to 18 Years

1. Each contestant shall agree to make one white cotton petticoat, made with a ruffle, and one corset cover. Machine work, hand sewing, and buttonhole making must all be exhibited on these pieces.
2. These two pieces of work shall be exhibited at the annual show.
3. Each contestant shall agree to do all the work without help.
4. Each contestant shall write a paper on the growth of cotton, and the processes involved in making it into white cloth.*

*Note.—These papers should be presented with exhibits

POULTRY CLUB

Boys and Girls, 10 to 18 Years of Age

1. Purpose.—To stimulate young people with a desire for better agriculture and to arouse and awaken interest in poultry raising.

2. Advisor.—An advisor should be selected to take the responsibility of making the club a success and supplying any needed help to the members. The advisor should be a mature person interested in the welfare of the club.

3. NAME.—The name of this club shall be the Boys' and Girls' Poultry Club of.....Township County.

4. MEETINGS.—Meetings shall be held once a month and at such other times as the president or advisor shall see fit to call the club together. These meetings shall be for the purpose of transacting business or listening to instructive lectures.

5. CONTESTS.—The club may take up any one of the contests suggested below, and when that one is finished, take up the next one if desired.

6. PRIZES.—The advisor should see that prizes in the way of cash, merchandise, eggs, stock, poultry books or magazines, be donated by enterprising poultrymen, and offered to the club members as a reward for their efforts. Have enough prizes so that nearly every member shall receive something.

7. REPORTS.—All reports should be handed in at the proper time to the secretary of the club, who in turn shall condense the material and report it to the Poultry Department at Purdue University.

8. FRAUD.—Care should be taken to prevent cheating or fraudulent practices, and to show the value of the members treating each other with fairness.

First Contest. April, May, June, July.
Second Contest. August, September, October, November.
Third Contest. December, January, February, March.

FIRST CONTEST:

Problem.—Hatching and Rearing Chicks

Method.—Each contestant must take 15 eggs of some pure bred variety, either from the home flock or from a donation and set under a hen. When hatched, they must be raised by a hen until August 1st.

Prizes to be given.—(1) To the member hatching the largest per cent. of eggs set.

(2) To the member showing at a July meeting the largest number of healthy chickens in proportion to the number hatched.

(3) To the member showing at a July meeting the largest total weight in proportion to the number hatched.

(4) To the member writing the best composition on hatching and rearing chickens.

SECOND CONTEST:

Problem.—Showing Chickens

Method.—Each contestant must raise the chicks hatched in the first period, and use only chicks from this hatch for this contest.

Prizes to be given.—(1) To the member with the highest scoring bird shown at some fair or poultry show held during the period, said exhibition to be decided upon by vote of the members.

(2) To the member with the bird best prepared for show.

(3) Where conditions will warrant, prizes for fancy stock of the various varieties can be offered.

(4) To the member receiving the greatest amount of money for a market fowl, said fowl to be sold to some one outside of the family.

(5) To the member with the highest pullet egg record for period.

THIRD CONTEST:

Problem.—Egg Laying Contest (Length of time to be decided upon by members)

Method.—Each member is to take eight females, pure breds preferred, of the same (any one) variety, and place them by themselves in some poultry house where they can be well cared for. Records must be kept of the weight and cost of feed and grit given, eggs and roost manure obtained, and time used for labor. These must be sent to the secretary at the end of each week and the total figures kept secret until the end of the contest.

Prizes to be given.—(1) To the member with the best total egg record.

(2) To the member with the best individual egg record.

(3) To the member producing eggs at the least cost per dozen.

(4) The member receiving the highest average price per dozen.

(5) To the member presenting the best written article on winter egg production.

Record of Contest for Third Period

EXPENSE ACCOUNT:

Date	Corn No. lbs.	Wheat No. lbs.	Oats No. lbs.	Bran No. lbs.	Shorts No. lbs.	Milk No. lbs.	Beef scrap No. lbs.	Grit, etc., No. lbs.

INCOME ACCOUNT:

Date	No. eggs sold	Price per dozen	Value	No. lbs. manure	Value
Total income					
Profit or loss					

BOYS AND GIRLS' POTATO CLUB

(10 to 18 Years)

1. Each contestant must agree to grow one-eighth of one acre of potatoes; hills to be not less than 14 inches apart in rows not less than 3 feet apart. (More or less than one-eighth of one acre may be grown.)

2. Each contestant shall do all the work without outside help, except in the case of contestants below 15 years of age, who may secure help in plowing or other heavy work.

3. Each contestant must write a history, of not over 500 words, telling how the crop was grown.

4. Each contestant shall select and exhibit one peck of potatoes, grown on his plot, at the annual show.

5. Each contestant should keep a record of all operations, number of bushels harvested, etc.

6. In awarding premiums the following basis shall be used:
 (a) Greatest yield per square foot..... 40 points
 (b) Best showing of profit on investment..... 30 points
 (c) Best exhibit of one peck of seed potatoes... 15 points
 (d) Best history on how the crop was grown... 15 points

 Total 100 points

Following is a record blank that might be used by each contestant:

Record of Potato Plot

(To be filled out by each contestant)

1. Contestant's name
 P. O. Address.....Rural Route.....
2. Variety of potato planted.....
3. Source of seed
4. Method of handling seed from time of gathering the previous fall to planting time.....
5. Treatment for scab:
 Material used Strength.....
6. Plot:
 Length in feet.....Width in feet.....
 Area in sq. ft.....Kind of soil.....
 Kind of subsoil.....
7. History of plot:
 (a) Crops grown there for three years previous to time of planting. 1910..... 1911..... 1912.....
 (b) Fertilizers applied during three years previous to time of planting. 1910..... 1911..... 1912.....
 Kind
 Amount

8. Fertilizers used in 1912:
 Kind
 Amount
9. Preparation of seed bed:
 Date of plowing.....
 Cultivation

Implements	Time used
.....	
.....	
.....	
.....	

10. Date of planting.....
11. Distance between rows
12. Distance between hills
13. Number of pieces per hill planted.....
14. Number of eyes to the piece.....
15. Weight of seed planted.....
16. Date of cutting seed.....
17. Date of appearance of plants.....
18. Cultivation:

Number	Date	Depth	Reason
1.			
2.			
3.			
4.			

19. Kind of cultivator used.....
20. Insects:

Kinds attacking crop	How controlled
.....	
.....	

21. Diseases:

Kinds attacking crop	How controlled
.....	
.....	

22. Stand of potatoes:
 Number of hills growing in plot.....
23. Date of maturity
24. Date harvested
25. Yield:
 Bushels on plot
 Bushels per acre

26. Cost of producing potatoes:

Value labor of boy at 12 cts. per hr.
Value team and boy at 25 cts. per hr.
Cost of plowing hrs. @ per hr.
Cost of preparing seed bed.....hrs. @ per hr.
Cost of manure or fertilizer
Cost of seed
Cost of planting hrs. @ per hr.
Cost of cultivation:
Harrowing hrs. @ per hr.
1st cultivation hrs. @ per hr.
2nd cultivation hrs. @ per hr.
3rd cultivation hrs. @ per hr.
4th cultivation hrs. @ per hr.
Hoeing hrs. @ per hr.
Other cultivation hrs. @ per hr.
Cost of spraying hrs. @ per hr.
Cost of spray chemicals
Cost of digging hrs. @ per hr.
Rental value of land for potatoes
Total cost
Yield of plot.....bushels
Cost of producing one bushel of potatoes
Cost of producing one acre of potatoes

BOYS' APPLE GROWING CLUBS

(10 to 18 Years)

Every farm homestead has its orchard. These orchards, however, are never a source of profit and are seldom even a source of home food supply. The reason for this can be summed up in the one word, neglect.

The object of this club is to interest the boys of the farm in the care of the home orchard. Great results can be secured from a small amount of well directed work on neglected orchards. There are men in this state today who are making fortunes by reclaiming these run down farm orchards.

Rules Governing Contest

1. Each contestant shall agree to prune, spray and otherwise care for one apple tree in a thoroughly up-to-date manner.
2. A complete record of all operations, labor and supplies expended on the tree shall be kept on blanks furnished.
3. An exhibit of one plate and one tray of fruit produced on the contest tree shall be exhibited at the county show, as well as a like quantity from the check or uncared-for tree.
4. Each contestant shall write a short essay on "How I reclaimed my apple tree."
5. A record of the total number of bushels gathered from the contest tree shall be kept, as well as a record of the total number of bushels gathered from an uncared-for tree of size comparable to that of the contest tree. The crop from each tree shall then be sorted into "marketable" and "unmarketable" fruit and the percentages of each obtained and recorded.
6. All work shall have been directed by the contestant and extra labor used shall be recorded in report.
7. All exhibits shall be judged according to the official apple show score card.
8. Final awards shall be made on the following basis:

Best tray	40 points
Best plate	20 points
Highest percentage of sound fruit per tree	20 points
Best essay	20 points
Total	100 points

Materials Needed

In order to secure the best results, the contestant should have the use of a good spray pump fully equipped. This can either be owned by the individual, owned in partnership with other contestants or owned by the school. Such an outfit should consist of a barrel pump capable of developing at least 85 pounds pressure. It should possess a large air chamber and a good agitator. The hose should be three-eighths inches in diameter and at least 35 feet long. A brass lined extension rod 10 feet long with a good eddy chamber nozzle will complete the outfit. Such an outfit will cost any where from $15.00 to $18.00. Materials for spraying one tree will not cost over $1.00. In two seasons the crop from a properly sprayed twenty year old tree will more than pay for the outfit.

Sample score cards and record blanks as well as full directions for all orchard operations will be furnished by this department.

Club Meetings

Meetings of clubs at stated intervals, under the personal supervision of school teachers, will maintain interest, train more thoroughly for the contests, make the work more truly educational and supplement the regular work of the school. The meetings may be held in the township high school or in some other central school house.

Printed Matter

Simple exercises that will be of great value to the boys and girls in preparing for these contests, and that may be taken up in club meetings, or in connection with the regular class work in schools, will be supplied, free of charge, by the Agricultural Extension Department. Special bulletins and circulars, dealing with the particular problems of the various contests, may be secured gratis from the Extension Department. Through this department agricultural books may be purchased at publishers' prices.

SHOW

The show where the products of the contests may be exhibited should be held at some central and accessible point in the county. A large suitable room should be provided and arrangements made to classify all entries. That is, the corn from each township should be grouped and a special place provided for bread and other articles. This will facilitate the judging and increase the educational value of the exhibit.

The show should be held as soon after corn harvest as is convenient. Shows held during late winter result in a loss of exhibits and of interest among the contestants. It is important to bring every exhibit and contestant into the show in the best possible condition and spirits. This means much in the results attained.

The winners in the various county contests will be eligible to enter their exhibits in the annual state show.

PREMIUMS

The matter of premiums is one of great importance. While the object of the contests is to create interest and educate directly, yet the young people look forward to winning a premium. For this reason provision must be made for a large number of premiums.

In the past there has been a general tendency to offer a few premiums of high value, but it is found that the offering of a large number of premiums though they be small, will do much to maintain interest and enthusiasm for future work.

It is also agreed that the more educational these premiums can be made, the better it is for the members of the club. A trip to the Farmers' Short Course at Purdue University; a trip to the State fair, or some other educational course or trip, with all expenses paid, means more to the recipient than would a cash premium. As a premium, it appears larger than the amount of cash required to finance the trip and creates greater interest in the work. The contestant is directly benefited as a result of the premium and at the same time goes back into the community and schools and is an inspiration to the other young people.

For the smaller premiums, suitable books and subscriptions to magazines or agricultural papers may be given.

For further information, address

Department of Agricultural Extension,

Purdue University,

LaFayette, Indiana



Fig. 4. Boys and girls judging corn



Fig. 5. County corn club boys judging live stock, Purdue Farmers' Short Course

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 39

LaFayette, Ind., July, 1913

AGRICULTURAL EXTENSION
XVIII

UNIVERSITY

PACKING INDIANA APPLES

Prepared Under the Direction of C. G. Woodbury
By W. R. Palmer

Methods of preparing apples for market have so changed within the last few years that but few of our growers fully realize the present demand for improved grading and packing. This circular discusses the equipment needed and the methods used in sizing, grading and packing both barrels and boxes. Recent legislation pertaining to the subject is noted in the appendix.

THE INFLUENCE OF IMPROVED PACKING

Among the qualities essential for attractive, appetizing fruit are neatness, cleanliness and uniformity. We choose largely from appearances—judging that the quality of fruit within the package corresponds to the appearance of what we see.

The orchardist is responsible not only for the quality of his fruit but also for its appearance and condition until it reaches the consumer. Methods of production are improving, but very little has yet been done to improve methods of marketing. Many growers realize that much good fruit is wasted because its preparation for market is too poor to meet outside competition. This competition can easily be met if apple growers will study their competitors' methods and adapt them to local conditions. Our market is undersupplied with first-class apples and while we delay improvement and progress, other producing sections, whose natural advantages are nowise superior to those of Indiana, continue to reap the benefit. Better *grading* and *packing* will enable Indiana apple growers to secure the full advantage of their home markets, will stimulate increased consumption and make production more profitable.



Fig. 1. Prize winning fruit at the second Indiana Apple Show. Upper row shows "3-2 diagonal" pack, 4½ tier. Lower row shows sweepstakes five box exhibit of Grimes, "2-2 diagonal check" pack. (First layer illustrated in Fig. 7) The middle box in the lower row won the grand sweepstakes prize for the best individual box and was scored 99 out of a possible 100 by Judge H. E. VanDeman

PACKAGES AND PACKAGE MATERIALS

Loose methods prevailed in fruit delivery up to a very few years ago. Apples were often heaped into wagons and boxes, brought from a distant orchard and peddled about to furnish householders with their winter's supply. As most people had their individual cellars and storage bins, this method of securing supplies in wholesale amounts was formerly fairly adequate.

However, with population congregating more and more in towns, cities and city apartments, the old time home storage is a thing of the past. Large amounts can no longer be stored and supplies must come often and in small amounts. Local storages and delivery systems have specialized in supplying the urban demand for these frequent small purchases and today the successful orchardist, in addition to his problems of production, must also study and solve the problems of scientific marketing and modern salesmanship.

These conditions have developed the package problem since the methods of marketing now used necessitate giving the package with the fruit.

The containers used have been of many shapes, sizes and materials, yet the two commercial apple packages most used are the familiar three bushel barrel and the more recent one bushel box. Each has its special use and value.

The Barrel.—Many attempts have been made to make a standard for an apple barrel. The latest attempt is embodied in the Sulzer bill which became a law July 1, 1913. (See appendix for text of the bill)

Barrel materials have been various, though elm and maple have predominated. Poplar and birch are also used for the heads. Six to eight hoops, generally sawed rather than split, give solidity though they should be renailed before packing. The main features should be strength and lightness, cleanliness, and attractiveness. Hence a grower should seek to obtain his supply early in the season, thus securing the best at least cost. Second-hand barrels often lose good trade mainly because of their soiled appearance. Neat, clean, new packages must be used if good packing is made profitable.

The barrel is best adapted for the wholesale handling of average grades. It is easily and quickly packed, can be handled easily in transportation and the three bushel amount of medium (or better) quality is a convenient unit of sale for many purposes.

The Bushel Box.—During the last few years there has been much used by growers of fancy apples, a bushel box which prevents considerable former loss of tender fruit and which is well adapted for retail trade. A summary of the advantages of the box over the barrel as a package for fancy apples follows.

1. Fancy fruit cannot be displayed to advantage in the barrel. The fruit in a box is more readily accessible for inspection or display.

2. The construction of the barrel package is not adapted for the packing of fancy or tender fruits. Apples should be packed tightly but to put fancy grades into so rigid a package and then to crowd on the head results in bruised fruit regardless of barrel padding used. The box is flexible because of its construction. The wood is made to bend rather than the fruit.

3. In large containers the greater amount of shrinkage in transit results in a slack pack with corresponding injury to the fruit.



Fig. 2. A convenient packing table for box packing. For dimensions and specifications see page 7

To overcome the results of shrinkage, the box permits a heaped bushel and as the contents shrink in storage the package conforms to the decreasing amount, so that the apple arrangement within is not disturbed. The pack remains firm and no fruits can be bruised in transit.

4. Modern city-home storage often precludes three bushel purchases. A bushel of high quality apples usable either for table or kitchen may often be sold where a larger amount could not be stored.

5. Daily purchasers of supplies in small amounts demand individual sanitary packages. The orchardist must conform to the

market demand for attractive, complete units, however small. The box package has a good reputation in all first-class markets and an individuality all its own.

The advantages of the standard box are mainly two:—it adapts itself to the shrink above mentioned and it caters to the city purchaser of small amounts. The box used in the recent Indiana Apple Shows is the one most used in the leading fruit districts. Following are the specifications:—

Dimensions:—10½ inches deep, 11½ inches wide, 18 inches long, inside measurements.

Materials:—Top and bottom two pieces each and three-sixteenths-inch thick in order to be flexible. Soft wood, such as pine or bass-wood, should be used. If harder wood is used, a thickness of one-eighth of an inch is ample; sides three-eighths of an inch thick in order to be rigid so that boxes may be piled on their sides in storage or transit; ends of one piece each and at least five-eighths of an inch thick. Four cleats are included and tops and bottoms nailed at the ends only.

As above mentioned, the box is best adapted for the higher grades of the better quality varieties. For fancy Jonathans, Grimes, Banana (Winter Banana), McIntosh, Winesap, Esopus (Spitzenburg), and possibly fancy Spy and Baldwin with others of like quality and elongated shape, the box is the ideal package. Well-grown Ben Davis has an ideal shape for box packing but it is not likely that low quality varieties can be marketed profitably in boxes. The cost of sizing and packing excludes from profitable box packing all but fancy apples.

Stimulus has been given the box method of apple packing by our foreign-born fruit venders. With variety, grade, size and number of contained fruits stamped on the box end and a uniform quality guaranteed by a co-operative marketing association, these venders purchase large supplies to retail singly and by the dozen. Each apple must stand individual inspection and because of sustained quality, the box package now has a good reputation for full measure. If uniform grading laws (as hereinafter discussed) are made and enforced over a wide territory, box packing can be standardized to the benefit of all concerned.

Carton.—Now that parcels post provides for carrying packages of increased weight at nominal rates, the carton is likely to become fairly popular. A dozen fine apples can be mailed a distant friend with the assurance that if in a suitable package, they will be delivered promptly without overcharge. These small packages might be made popular gifts if properly prepared and advertised.

SIZING AND PACKING EQUIPMENT

For Barrels.—As ordinarily arranged, not much equipment has been required in grading for barrel packing. A long sloping table, with raised sides high enough so that the graded apples would drop into the barrel has been used and has been responsible for much bruised fruit. A better plan is to use a burlap covered frame on which the apples are first put. This should be about four feet wide and eight feet long. On the opposite side from the person grading, receptacles or canvas chutes may be arranged for each grade desired. Sample apples of each grade should be kept constantly in view and the sizing can thus be made quite uniform.

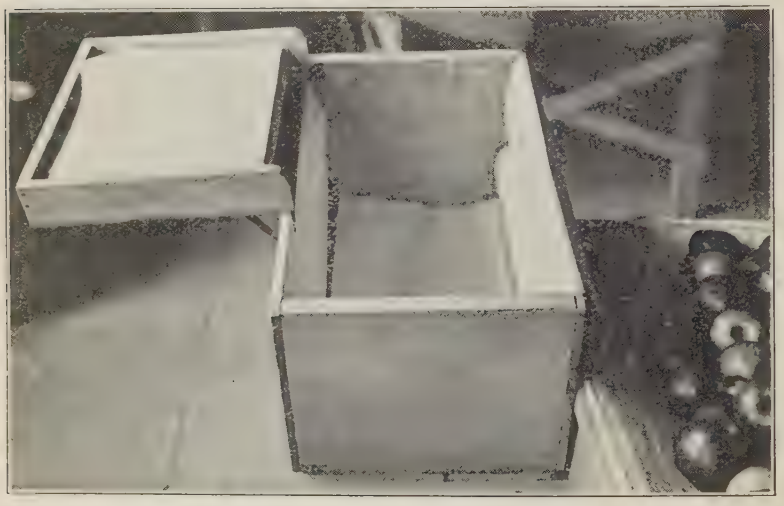


Fig. 3. Box in position on table ready for packing, showing lining paper in box and hod on box side for holding individual wrapping paper

The barrel hoops may need some adjustment. *Nails* used for renailing and heading are ordinarily 3 D size. A *corrugated circular cap* of cardboard, smooth side next the apples, is often used at each end when the barrel is being filled. Very seldom is the barrel lined. The use of a lace collar over the face layer may be practical for the finest grades of fruit. It does not often pay with the average grades. The *press* used for heading may be either of the screw or the lever type but should be so adapted that the greatest downward pressure may be applied around the outer part of the inserted head rather than across the center. A ring top on the press is preferable to the usual bar top. A home-made ring about 14 inches

in diameter can be used for this and inserted between the barrel head and the cross bar of the press. It may be made from a 1½ or 2 inch wagon tire and its use prevents much bruising directly under the center of the inserted barrel head. A *hatchet* and *hoop follower* complete the equipment. The follower is simply a piece of hard wood concaved along one side so that it may fit the barrel side as the hoop is being driven down when heading.

For Boxes.—A burlap or canvas covered frame about 3 x 5 feet, waist high, is best adapted for hand sizing and grading. (See Fig. 2) Built as mentioned below, it is also used when packing boxes.

Top—3 feet x 5 feet. Capacity about 4 bushels.
Height—about 38 or 40 inches.
Materials:—

4	pieces	1 inch	x 6	inches	x 4	feet	(2 projecting ends and 2 box rests)
2	"	1 "	x 6	"	x 5	"	(sides)
4	"	2½ inches	x 2½	inches	x 38 inches or 40 inches		(legs)
4	"	½ inch	x 3	"	x 5½	feet	(side braces)
4	"	½ "	x 3	"	x 3½	"	(end braces)

Cover top with burlap or canvas leaving slack enough for center to sink 3 to 5 inches.

Bevel inner corners of leg tops to prevent bruising of fruit and prevent cutting burlap. A second burlap is often also used fastened only at one end; it aids in quickly clearing top of accumulated leaves, stems and other debris. Nail hose around edge of top for cushion.

Crates or empty boxes may be used for the graded fruit. Where a mechanical grader is used for the sizing, a different arrangement will be needed. The boxes may have come in the shook and will need to be set up. *Cement-coated box nails* should be used. For each end of the sides use four nails of about 4 D size. Through each cleat the bottom should be nailed at each end with four nails of about 6 D size. If wrapping paper is used a light tray or hod to be hung on the side of the box is also needed. (See Fig. 3)

The use of paper is necessary in box packing to secure neatness and cleanliness. In addition to the protection from bruising, the paper acts as an absorbent where one decayed apple would infect others adjacent. The slight extra expense for lining and wrapping paper increases the selling price from 10 to 50 cents per box. Of *lining paper,* two sheets are used large enough (17¾ x 28 inches) to overlap on the bottom of the box, provide for a fold at the bottom edges (to accommodate bulge expansion) and again overlap at the top after the box is filled. Unprinted newspaper stock is used for this. The fold or crease in each sheet is made about five or six inches from one end, thus permitting the paper to unfold instead of tearing as the box bottom is depressed while the cover is

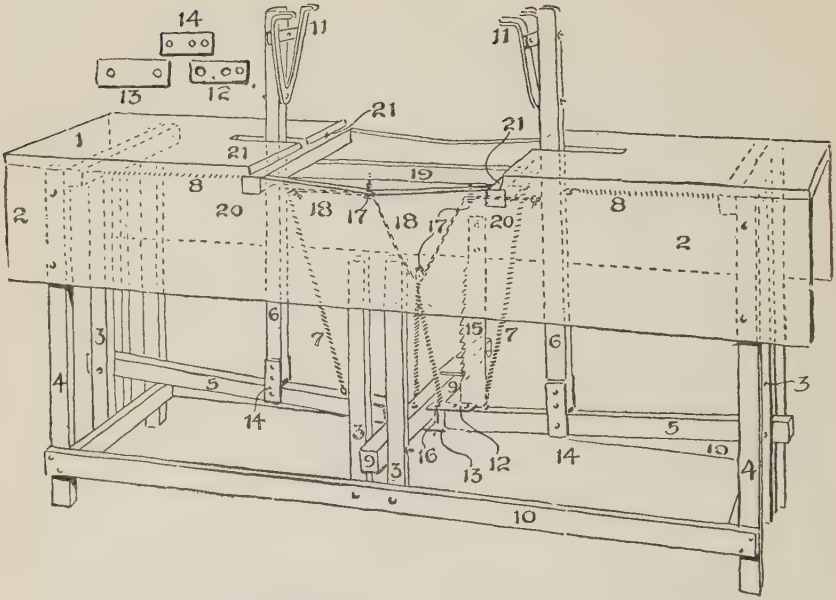


Fig. 4. 1. Cover boards to table. Length of table, 64 inches

2. Side board to table
3. Uprights for attachment of levers (5 and 9)
4. Legs of table, 28½ inches long, 1½ inches square. (All the arms, legs and levers of the press may be made of 1½ × 1½ inch material)
5. Levers, 27 inches long
6. Upright arms, 32 inches long
7. Steel springs. Small screen door springs may be used
8. Spring attached to upright arm (6) and support (3)
9. Foot lever, bolted to uprights (3) at back, and working with catch plate and ratchet in front. It is fastened to plate (13)
10. Brace for legs and lower support for uprights. Three inches from ground
11. Horseshoe plate for gripping box cleats and cover
12. Iron plates bolted to levers (5), with large holes in projecting ends, allowing the bolts (16) to slide freely
13. Lower plate under lever (9), to which it is bolted loosely, with large holes in each end for free play for bolts (16)
14. Side plate joining lever (5) and arm (6). Loose joint
15. Iron ratchet to engage plate on the front lever (9)
16. Half-inch bolts, 2½ inches long, working loosely in the holes in the plates (12 and 13)
17. Three small pulleys for rope attached to arms (6)
18. Strong ¼ inch cord that will not stretch
19. Spanner running parallel with side
20. Cross pieces, providing support for box
21. Grooves for holding box in place. They are a trifle over 18 inches apart

being nailed on. Five or six sheets of *layer paper,* 11½ inches x 18 inches, are used to each box. A sheet follows the placing of the lining paper with another between every layer of apples. One is placed on top when the lining paper ends are folded across. It should be absorbent—often a low-grade blotting paper—and generally of a contrast color to the fruit, as blue or drab. Individual *wraps* are used only in the fancy packs or when shipping to a distant market. These are of thin paper (glazed or tissue) and of various sizes, the 9 x 10 inch size being much used. The successive movements used by many professional packers are as follows: the paper is held on palm of left hand and an apple snapped onto it by the other hand. The left thumb pushes up and holds down a corner of the paper while the first and fourth fingers draw in on either side, the two diagonal corners. With a turn of the left wrist (thus holding apple and palm downward) the remaining corner of the paper can be brought down and under by the right hand, thus binding all together as the apple is placed in position in the box. Some prefer to have the wrapper ends next to the cover to act as individual pads while others prefer to have the smooth wrapping show when a box is opened up for inspection.

The expense of lining and layer paper is about two cents per box; wrapping individual fruits costs about as much more. An additional expense for distinctive box labels is not recommended except for large shippers of fancy fruit. For the first 10,000 labels the cost is about one cent each though each additional thousand costs but half this price. A grower who takes pride in his product should, however, label each box or other package with his name, address and variety of the apple, and if a box, the number contained. Such identification is required in many states. A rubber stamp may be used for the purpose.

To assist in training the eye to note slight variation in apple sizes, a *grading board* is sometimes used the first day. Holes of different diameters are cut into a board and with this suspended near the person sizing, a definite standard is available for comparison whenever doubt arises.

Some form of power press is necessary to hold and compress the cover ends while nailing. There are two or three steel presses on the market selling for about $12.00 each. A home-made nailing press much used at Hood River is shown in Fig. 4 and costs about $5.00 or $6.00. The construction permits the box bottom to be depressed, thus assuming half the bulge of the open box. The drawing and description in Fig. 4 is from Bulletin No. 298, Cornell University Agricultural Experiment Station and is an adaptation of the drawing and description published in "Better Fruit," September, 1909, 1910, 1911.

SIZING AND GRADING

With the wide variance of late years in the size and quality of apples, the necessity arises for definite standards of value. The many specialized uses for apples make it desirable to have uniformity in each recognized package. Apples as packed for market should be uniform in *variety, shape, size, color, degree of maturity, quality* and *appearance.* Uniformity indicates care, reflects quality and promises full value.

The average grower imagines that the largest fruits in a mixed lot determine its value to the purchaser. We find crates and barrels faced with this idea in mind. The critical buyer is greatly influenced by what he can see, yet experience has taught him to examine within.



Fig. 5. The face layer of a barrel pack. Note compact and attractive appearance. The circles contain seventeen, ten and three apples respectively

His valuation is based on the poorest specimens with nothing extra paid for those of better quality. Both buying and selling may be more satisfactorily carried on if the contents of a package are of a definite grade. Standardized in this way, the producer can set a definite price with the expectation of receiving it. The purchaser, knowing that it is standard, gets definite value for a definite price. In fact, some of the most easily made money in the apple business is made by this very plan of sorting a lot of mixed sizes so that each grade is uniform and attracts buyers who desire that grade. All grades can be sold but the grower should realize that he is wasting money by mixing grades or by trying to mislead experienced buyers.

THINNING.—It might not be out of place to say that much expense in sizing and grading can be saved if more growers would practice thinning early in the season. This is needed especially for box packing as the remaining fruits are more uniform in size.

Even with the thinning of the "June drop" many fruit spurs still contain clusters of three and four apples each. These apples in clusters are more subject to insect and fungus injury than single fruits and they do not color as well. On heavily loaded trees such as Winesap each cluster should be thinned to contain not more than two fruits and if occasion justifies only one should be left. They cannot be removed wholesale, but can be quickly thinned by snipping the stems with thinning shears and letting the fruit fall. Removal of these misshapen and diseased apples gives the others a better chance for growth, lessens the picking and grading expense, and permits the stem to remain in the apple and the spur on the tree. Handle carefully. Bruises are mortgages due within ninety days. Place fruit in storage or shade as soon as picked as the first twenty-four hours' care decides its storage life.

GRADING FOR THE BARREL.—A national law affecting apples in barrels is the Sulzer Bill before mentioned. (See appendix for text of bill) The provisions of the Sulzer law make it necessary for fruit to be only 90 per cent. as good as the guarantee. Growers who value their future trade must continue to make their pack 100 per cent. as good as the guarantee. In addition, the "facers" must be representative of the grade packed if confidence in the grower's brand is to be established.

GRADING FOR BOX PACKING.—Indiana should adopt, especially for box packing, a definite set of directions for sizing, grading and marking all apple packages. Such adoption would bring about uniformity of pack in all parts of the State. Uniformity of product helps to secure uniformity of prices.

Various efforts have been made in years past to standardize apple packing. The Canadian Fruit Marks Act has been very helpful to Canadian fruit growers. (See appendix for the text of this law) The following definitions of grades were adopted by the American Pomological Society in 1907:

" 'Fancy' or 'Extra' grade shall consist of well-grown specimens of one variety, of uniform and at least normal size, of high color for the variety, of normal shape, free from insect and fungous injuries, bruises or other defects and properly packed.

'Choice' grade to consist of well-grown specimens of one variety of not less than medium size, of good color for the variety, normal shape, and not less than 90 per cent. free from insect, fungous, or other injuries impairing the soundness of the fruit and properly packed.

.....Size in all grades where practicable shall be indicated by diameter in inches, or by approximate number of fruits per unit, as per package, pound, quart, peck or bushel."

The classification followed by many Pacific Northwest shippers is as follows:—



Fig. 6. A common type of lever press. A screw press is generally preferred and should have a ring, instead of a bar-top. The upper hoop must be removed and the second one loosened to allow head to be pressed down. A corrugated cap should be placed between the apples and the barrel head

"'Fancy.'—Apples shall be of good natural, matured color, except for cold storage purposes (when they shall be a little green) shall be hard, smooth and free from discoloration, free from worms,

scale, or sun damage, true to variety named and shall have stem intact.

'Choice.'—Apples shall be of fair color, somewhat less smooth and firm than fancy and reasonably free from scars and discolorations. Shall be free from sun or worm damage.

A reasonable allowance for variation in size of apples shall be made for hand sorting, and all apples shall be sorted not longer than ten days before packing." In addition, definite directions were issued stating that red varieties must be at least 70 per cent. red, that windfalls and bruised apples would not be accepted, etc. Reputation comes as a result of sustained quality and the need of standardization is yearly more apparent.

In brief, one must have in mind the standard for each size and grade. Receptacles must be provided for each classification. For box packing a pile of many sizes may be most quickly and accurately segregated by successively removing the largest specimens to their receptacle; then the smallest sizes to their crate or box. This mode of separation is continued until all are sized. Correct size should be graded as required. Generally this includes the degree of color so that poorly colored specimens may not be packed with those of high color.

PACKING THE BARREL

Having the apparatus at hand and the apples ready to be packed, the following operations are required.

Facing.—Into the empty barrel is first put a corrugated circular cardboard cap, corrugations next the wood. On this cap the 'facer' apples are placed in concentric circles. The first circle around the outside should be of uniform sized apples. Should they not fit closely on completing the circle, a different size should be chosen; do not choose a single specimen of different diameter to fit the one space requirement. The next inner circle being smaller, will contain from five to eight fewer apples and being of a uniform size in that circle, they should fit as snugly as the preceding. The next inner circle (the third) may contain five or six apples though seldom are apples used so small in size that this third circle contains so many. If five are contained, it provides room for a final center apple to complete the face layer. Fig. 5 shows a three circle (17-10-3) layer.

As later mentioned in box packing, this first layer is placed with the stem end of apples next the barrel head. The stem end being broad and fairly flat, little bruising occurs. In addition, this face layer may be made attractive if care is taken to choose apples of uniform size, color, and shape. If the fruits are of such size that

different sized circles contain different sized apples, it ought to be arranged so that each smaller circle should contain apples of increased diameter. Thus the face layer appears attractive, a true representation of the quality in the center of the barrel.

Some shippers double-face a barrel, but a better plan is to place the apples in this second layer on their sides, down into the larger



Fig. 7. A "2-2 diagonal check" pack, 3½ tier. This pack, suitable for large apples runs about 96 apples per box. It may be adapted to slightly differing sizes by placing the stem end up

cavities of the preceding layer. A barrel is thus more completely filled and the well-colored sides of these apples show through, and add to the appearance of the face layer when a packed barrel is reversed and the head opened. The remainder of the barrel is quickly filled by basket or otherwise. Rack or shake the barrel during this jumble filling so that it may be compactly filled. Care must

be taken during the filling of the last few inches to provide a level or slightly oval base for the final crowning or tailing of the barrel. (See Fig. 6) This last crown layer should be placed with the stem upward to better withstand the firm, unyielding pressure of heading. Some shippers prefer this crown with stems of all apples up while others change the outer circle of this crown and have them placed on their sides. The outer circle of apples in this convex crown layer should project about an inch and a half above the end of the stave, the center fruits being proportionately higher. To protect the fruit, especially this top layer, from being crushed when the rigid head is adjusted, another corrugated cap is added as a cushion. Some shippers use an excelsior padded cushion but it does not protect in proportion to the room it occupies. If necessary, two corrugated caps will give far better results. A screw or lever barrel-press assists the operator in forcing the barrel head down, although the upper barrel hoop must first be removed, and the second hoop raised its width, to allow the head to fit into the groove. (See Fig. 6) The hoops are then driven down and 3 D board nails used to nail through the chime into the different boards of the head. Sometimes two strips of pliable wood, termed liners, are nailed within the barrel top for additional safety. The barrel head may be guided into position with well directed blows with the flat side of the hatchet. The use of the hoop follower saves hoops when forcing them back into place. The barrel head is then stenciled in conformity with the Sulzer law requirements. The barrel is generally placed on its side in storage.

PACKING THE BOX

Our standard apple box may be packed with a dozen or more different sizes. Different arrangement permits this and anyone having carefully sized apples can become skillful, first, by knowing the technique, and second, by practice to attain speed.

Selecting the Right Pack.—Having a quantity of apples all of one size, the beginner must determine what arrangement or style of pack is best. Knowing the diameter or the circumference, let the packer locate that size in the "Outline of Box Packs." (See page 17) If the apples have a circumference of ten and one-half inches or thereabouts, they may be arranged as a "2-2 diagonal" pack (See Fig. 7) and will contain about 96 apples. There would be four layers and inasmuch as it takes between three and four apple diameters to equal the box width, it is known as "3½ tier." In Fig. 8 is seen the start of this "2-2 diagonal" pack with long apples packed with the cheek up.

A circumference of eight inches permits the use of a "3-2 diagonal" pack. (See Figs. 9 and 10) It would contain about 163 apples, its five alternating layers having 33 and 32 apples each. As more than four diameters, but less than five, would be needed to measure the box width this pack is known as "4½ tier."



Fig. 8. Showing start of a "2-2 diagonal" pack as illustrated in preceding figure

Apples of about nine and a half inches circumference may be packed as a "straight pack" (see Fig. 11) containing four layers and 112 apples. The essential feature is that *full value must be packed* and the outline given on page 17 shows the style best adapted for any particular size. The shape of an apple sometimes necessitates placing apples on their sides, or with core line diagonal to the box sides but the relative position of each fruit in the layer always remains the same. (See Fig. 12)

In other than cheek packs the apples should be packed in the box stems down, until the top layer is reached when they should be packed stem end up. When the cheek pack is used with the apples on their sides the core line may be parallel to the box side (see Fig. 7) or diagonal to it. (See Fig. 12) Apples are never packed crosswise of the box or with the core line at right angles to the box side.

The sizing and grading for box packing has been mentioned before and with the fruit ready to be packed, the methods of arrangement will now be considered. The following outline will be found helpful in deciding what pack to use.

OUTLINE OF BOX PACKS

	Approximate lateral circumference	Style of pack	Number apples per box	Layers and number in each	Number in first and second rows	Box marked
A	12 inches	Straight 3	45	3 x 15	5-5	3 tier
B		Straight 3	54	3 x 18	6-6	3 "
C	11½ "	2-2 Diagonal	56	4 x 14	4-3	3½ "
D		Straight 3	63	3 x 21	7-7	3 "
E	11 "	2-2 Diagonal	64	4 x 16	4-4	3½ "
F	10¾ "	2-2 Diagonal	72	4 x 18	5-4	3½ "
G	10½ "	2-2 Diagonal	80	4 x 20	5-5	3½ "
H	10 "	2-2 Diagonal	88	4 x 22	6-5	3½ "
J	9⅞ "	2-2 Diagonal	96	4 x 24	6-6	3½ "
K	9¾ "	2-2 Diagonal	104	4 x 26	7-6	3½ "
L	9½ "	3-2 Diagonal	113	3 x 23 2 x 22	5-4	4½ "
M	9 "	Straight 4	96	4 x 24	6-6	4 "
N		Straight 4	112	4 x 28	7-7	4 "
O		3-2 Diagonal	125	5 x 25	5-5	4½ "
Q		3-2 Diagonal	138	3 x 28 2 x 27	6-5	4½ "
R	8⅞ "	4-4 Offset	140	5 x 28		4½ "
S	8½ "	3-2 Diagonal	150	5 x 30	6-6	4½ "
T		3-2 Diagonal	163	3 x 33 2 x 32	7-6	4½ "
U	8 "	3-2 Diagonal	175	5 x 35	7-7	4½ "
W		3-2 Diagonal	188	3 x 38 2 x 37	8-7	4½ "
X	7½ "	Straight 5	200	5 x 40	8-8	5 "
Y		Straight 5	225	5 x 45	9-9	5 "

The completed box should be stenciled on one end with:—
(a) The name and address of the packer
(b) The variety and grade of apples
(c) The tier and number of contained fruits

Packs.—There are two general arrangements or styles known as *straight packs* and *diagonal packs*.

Straight Packs:—In the straight packs the rows of apples are parallel to the sides of the box and at right angles to the ends. Hence, in one of the larger apple sizes, three parallel rows, extending from one end of the box to the other, make a layer of full width. By adding other layers of that same sized apple, the filled box is said to be a "straight" pack. Arranged in this way the uniformity of



Fig. 9. The "3-2 diagonal" pack, 4½ tier, containing about 163 apples per box. This is the most popular of the box packs. It is adapted to medium sized apples.

position is pleasing and the fruit is displayed to good advantage. If an apple is of such a size that its diameter is one-third of the box width, it may generally be packed as above described and is called "three tier." Refer to the first two in the "Outline of Box Packs." If its diameter is but one-fourth of the box width, it might be packed as a straight pack and labeled "four tier." (See Fig. 11 and refer

to 112 in the "Outline") A layer five apples wide would be labeled "five tier." Thus only these three different diameters or sizes can be used in the straight packs; consequently it has only a small range of adaptability. A more serious objection is that straight packs bruise easily; apples in one layer press directly on apples of the layer adjoining. Moreover, the straight pack is not so compactly nor quickly put up by the beginner. Its several objections are overcome in the diagonal styles mentioned below.

Diagonal Packs:—A diagonal arrangement in each layer permits as much, or more, fruit to be placed in the package and allows any apple in an upper layer to rest in the depression formed by three or more apples of the layer below, thus lessening the opportunity for bruising. Furthermore, the diagonal styles have a wide range of adaptability, are easily learned and can be quickly packed.

A study of Fig. 7 and Fig. 9 show the layer arrangement in the two most popular diagonal packs, the "2-2 style" and the "3-2 style." As indicated in the "Outline of Box Packs," the "3-2 pack" will accommodate sizes varying from eight inches to nine and one half inches in circumference. The "2-2 pack" will accommodate apples varying from nine and three-quarters inches to eleven inches in circumference. Thus with a given sized apple, one sometimes has a choice between these two styles and perhaps a third, a straight pack.

Having to pack a size eight inches in circumference, the "Outline" indicates the "3-2 style." Three apples are first placed at one end of the box, one in each corner with the third midway between the two. Into the two spaces thus provided two more apples are placed, though both project about half their diameters thus creating a new set of three spaces. Into these are placed three apples which project about half their diameters and another two spaces are created. The filling of these spaces proceeds until that layer is completed, every apple having been firmly placed and no space left at the end of the layer. If trouble is experienced with layers not coming out even, see topic, "Alignment and Layer Compactness."

The second layer of the "3-2 pack" is the reverse of the first, so that the second layer apples may fit into the depressions of the first layer. Hence this second layer will start with two apples because the start of the previous layer had left two depressions. The second layer is then completed. If the first layer ended with three apples, the second layer ends with two; if the first layer ended with two apples, the following layer must end with three apples to fill the three spaces beneath.

The third layer, in alternating with the preceding, will be similar to the first layer. Likewise, the fifth (the last) layer will be similar to the third and hence also to the first layer. The second and fourth layers will be similar. Throughout the packing process

one must continually keep in mind the proper *alignment* and *layer compactness,* the *bulge,* and the *height of ends,* as later described.

Contrasting "T" and "L" of the Outline, both are seen to be "3-2 diagonal" packs, yet one contains 163, while the larger size, (9½ inches in circumference), contains 113 apples. In the first layer of "T," (Fig. 9) the rows in length are respectively 7-6-7-6-7 representing 33 apples. As alternate layers are similar,

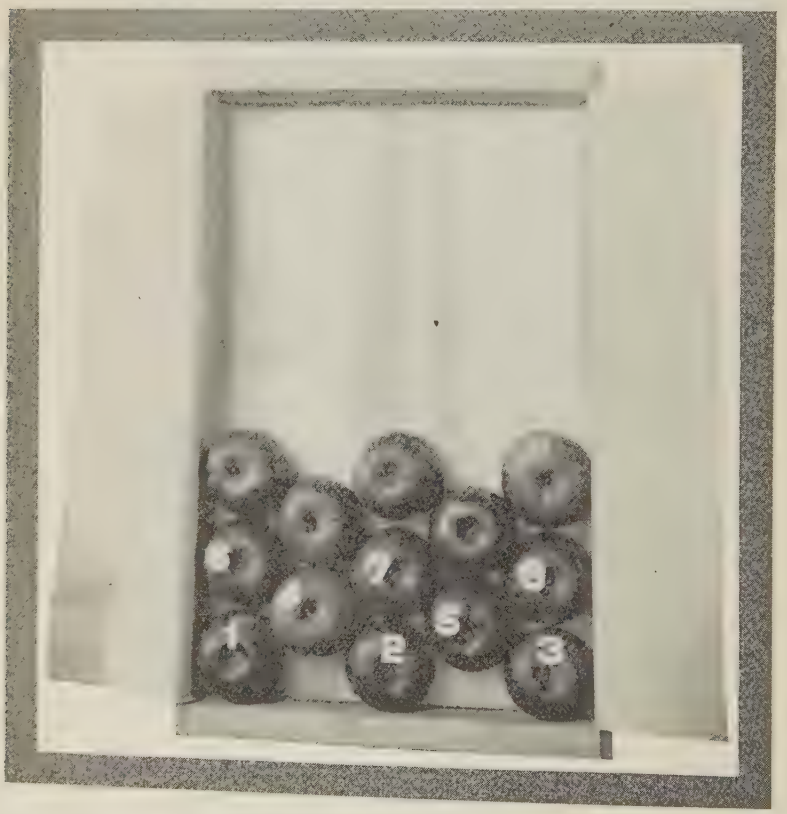


Fig. 10. The start of the "3-2 diagonal" pack. The apples are placed in the layer in the order in which they are numbered. Keep the rows 1-6, 2-7, 3-8 even as the packing of the layer proceeds

the third and fifth layers each have a like amount or the three a total of 99 apples; and as the first layer provided but 32 depressions, that is the number of apples in the second layer. The fourth layer has a like number or the two a total of 64 apples. Thus the box is stamped on the end as containing 163 apples. Other styles are quickly counted in similar manner.

With larger apples than nine and one half inches in circumference, the "2-2 style" must be used. Apples of such a size that more than three but less than four are needed to go across the box are termed "3½ tier" and the "2-2 style" is thus labeled. The term "tier" is the approximate number of apple diameters across a box. Only whole and half numbers are thus termed tier.

Start the "2-2 style" as in Fig. 8. The first two apples placed at the end of the box provide two spaces which are partially filled by two additional apples. These last two apples project enough to provide two new spaces to be filled. Thus the layer is completed with every apple snugly placed. The second layer starts with its first two apples being set into the first two spaces of the preceding layer. Other apples are added as in the first layer. Four layers (see Outline) are used for apples large enough to be packed in this style. By referring to illustrations and the packing Outline, both the "3-2" and the "2-2" styles can be commercially packed, providing accurate sizing has previously been done. Grade and size accurately, find the style in the packing Outline best adapted to that particular size and the operations of box packing will be soon learned.

Other Packs:—In Fig. 13 is shown the top layer of an offset pack, described at "R" in the Outline. It is not recommended except for apples of peculiar shape, as too much space is left at either side of each layer. For very large apples (four to five inches in diameter), a "2-1" pack is sometimes used though it is doubtful if such large sizes can be used in box packing to advantage. Another pack is the "3-3 style." (Fig. 14) packed similar to the "2-2 style" described above. This style does not permit full weight and count except in one or two sizes and thus is not recommended.

BOX PACKING PROBLEMS

Alignment and Compactness.—When the grading has been well done the alignment is easily secured. By keeping the lateral rows even as you proceed in each layer, the companion rows reach the end of the box at the same time. Where trouble is encountered in a layer coming out slack at the end, it may generally be found that by removing the three or four *undersized* specimens present in that layer and substituting the normal size, all are made firm in position. Perhaps the slack layer may contain four or five *overlarge* apples. By replacing them with the normal size, enough room is gained at the end to admit additional apples necessary to make the layer firm. Often more layer end room may be obtained by forcibly drawing that layer endwise until the needed space is gained. Fig. 9 shows good *alignment* and *compactness;* Fig. 14 (not recommended) just the reverse.

Bulge.—By using the more elongated apples across the center of each layer, and the flatter apples at the ends of that layer, the cen-

ter of the pack may be from one to one and one-fourth inches *higher* than the end of the box. This is called the swell or bulge and allows for a certain amount of shrinkage. With thin, elastic, soft wood used for box tops and bottoms, a box will conform during storage to this shrinkage and still keep the contents compact. Fig. 15 illustrates proper bulge.



Fig. 11. Four tier straight cheek pack, 112 apples per box, four layers. A very attractive pack but has the disadvantage of causing more bruising than the diagonal pack

Ends of Ends.—To be well packed, the ends of the top layer must be flush with the top of the box. This is secured by having used the more flat apples for the ends and the larger ones, as above mentioned, at the center. Extremely flat apples may be packed with the cheek up for a layer or two and the desired height thus gained.

The well packed box must contain fruits of one size, compactly and uniformly placed, so that full value is secured with attractive appearance.

APPENDIX

The Sulzer Bill, H. R. 21480

AN ACT to establish a standard barrel and standard grade for apples when packed in barrels, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled. That the



Fig. 12. A "3-2 check" pack with the core-line diagonal to the box-end; contains 113 apples per box. This pack may be used for apples slightly larger than will go in the regular "2-2" pack shown in Fig. 9.

standard barrel for apples shall be of the following dimensions when measured without distention of its parts: Length of stave, twenty-eight and one-half inches; diameter of head, seventeen and one-eighth inches; distance between heads, twenty-six inches; circumference of bulge, sixty four inches outside measurement; representing as nearly as possible seven thousand and fifty-six cubic inches.

SEC. 2. That the standard grades for apples when packed in barrels which shall be shipped or delivered for shipment in interstate or foreign commerce, or which shall be sold or offered for sale within the District of Columbia or the Territories of the United States shall be as follows: Apples of one variety, which are well-grown specimens hand picked, of good color for the variety, normal shape, practically free from insect and fungous injury bruises, and

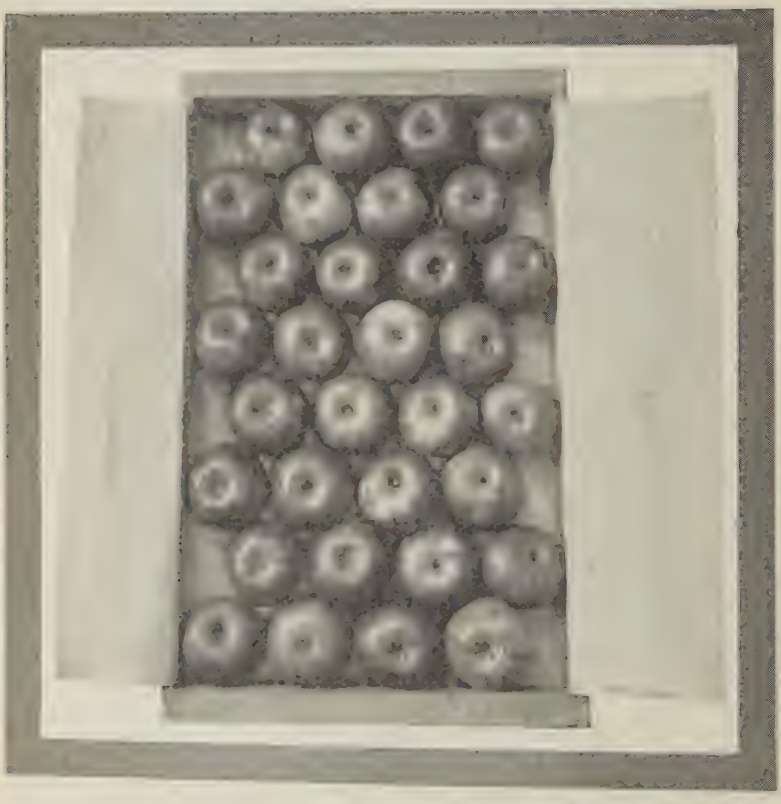


Fig. 13. Top layer of a "4-4 offset pack," 4½ tier. This pack is seldom needed and is not recommended because of the large spaces along sides of box

other defects, except such as are necessarily caused in the operation of packing, or apples of one variety which are not more than ten per centum below the foregoing specifications shall be "U. S. Standard minimum size two and one-half inches," if the minimum size of the apples is two and one-half inches in transverse diameter; "U. S. Standard minimum size two and one-fourth inches" if the minimum size of the apples is two and one-fourth inches in transverse diameter;

or "U. S. Standard minimum size two inches," if the minimum size of the apples is two inches in transverse diameter.

Sec. 3. That the barrels in which apples are packed in accordance with the provision of this Act may be branded in accordance with section two of this Act.

Sec. 4. That all barrels packed with apples shall be deemed to be below standard if the barrel bears any statement, design, or de

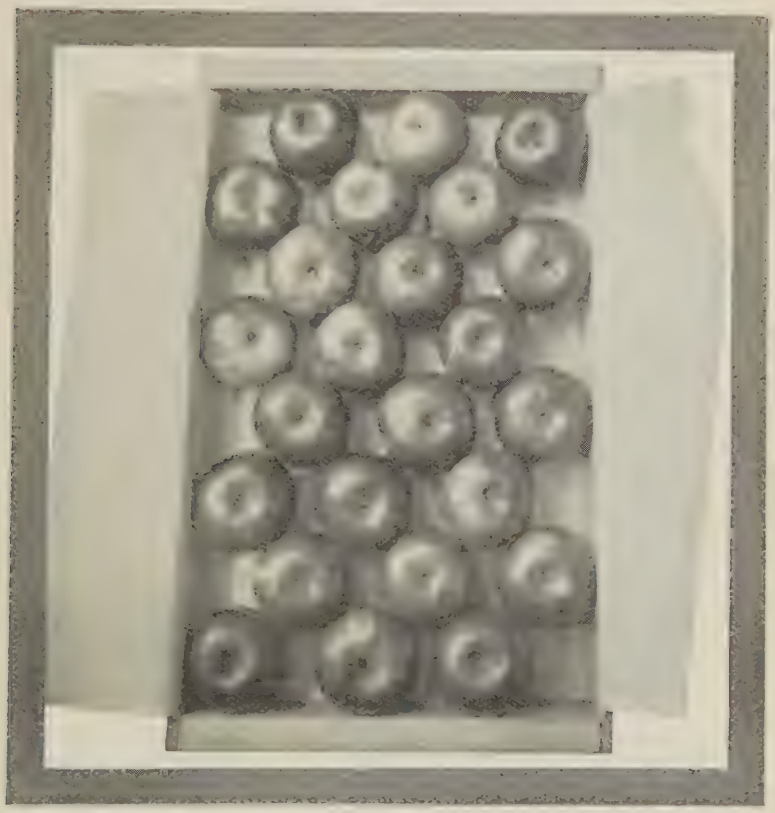


Fig. 14. The "3-3 diagonal" pack; not recommended because of too much waste space. The cut shows poor alignment

vice indicating that the barrel is a standard barrel of apples, as herein defined, and the capacity of the barrel is less than the capacity prescribed by section one of this Act, unless the barrel shall be plainly marked on end and side with words or figures showing the fractional relation which the actual capacity of the barrel bears to the capacity prescribed by section one of this Act. The marking required by this paragraph shall be in block letters of size not less than seventy-two point one-inch Gothic.

Sec. 5. That barrels packed with apples shall be deemed to be misbranded within the meaning of this Act—

First. If the barrel bears any statement, design or device indicating that the apples contained therein are "U. S. Standard" and the apples when packed do not conform to the requirements prescribed by section two of this Act.

Second. If the barrel bears any statement, design, or device indicating that the apples contained therein are "U. S. Standard" and the barrel fails to bear also a statement of the name of the variety, the name of the locality where grown, and the name of the packer or the person by whose authority the apples were packed and the barrel marked.

Sec. 6. That any person, firm or corporation, or association who shall pack or cause to be packed apples in barrels or who shall sell or offer for sale such barrels in violation of the provisions of this Act shall be liable to a penalty of one dollar for each such barrel so sold or offered for sale, to be recovered at the suit of the United States in any court of the United States having jurisdiction. This penalty to be recovered under the provisions of an Act approved June thirtieth, nineteen hundred and six, entitled "An Act for preventing the manufacture, sale, or transportation of adulterated or misbranded or poisonous or deleterious foods, drugs, medicines, and liquors, and for regulating traffic therein, and for other purposes." (Thirty-four Statutes, page seven hundred and sixty-eight)

Sec. 7. That this Act shall be in force and effect from and after the first day of July, nineteen hundred and thirteen.

THE CANADIAN FRUIT MARKS ACT

In addition to the definitions given below this act provides for the appointment of inspectors and defines their duties, provides for fines of from twenty-five cents to one dollar per package in case of violations and gives the details of methods of enforcement.

"Section 4. Every person who, by himself or through the agency of another person, packs fruit in a closed package, intended for sale, shall cause the package to be marked in a plain and indelible manner, in letters not less than half an inch in length, before it is taken from the premises where it is packed,—

(a) With the initials of his Christian names, his full surname, and his address, or, in the case of a firm or corporation, with the firm or corporate name and address;

(b) With the name of the variety or varieties; and

(c) With a designation of the grade of fruit, which shall include one of the following four marks, viz: "Fancy," "No. 1," "No. 2," "No. 3," for such mark may be accompanied by any other designation of grade or brand, provided that such designation of grade or brand is not inconsistent with, or marked more conspicu-

ously than, the one, of the said four marks, which is used on the said package.

Section 5. No person shall sell, or offer, expose or have in his possession for sale, any fruit packed in a closed package and intended for sale, unless such package is marked as required by the next preceding section.

Section 6. No person shall sell, or offer, expose or have in his possession for sale, any fruit packed in a closed package upon which is marked any designation which represents such fruit as of,—

(a) "Fancy" quality, unless such fruit consists of well grown specimens of one variety, sound, of uniform and of at least normal size and of good colour for the variety, of normal shape, free from worm holes, bruises, scab, and other defects, and properly packed:

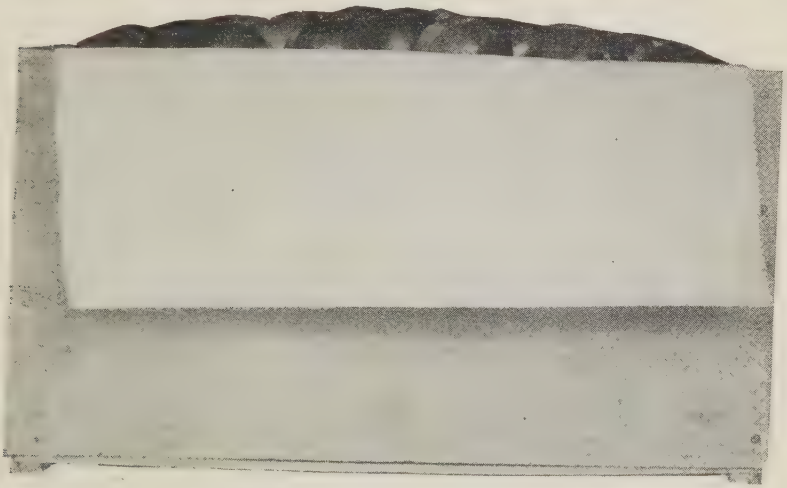


Fig. 15. Showing correct bulge in packed box ready for nailing

(b) "No. 1" quality, unless such fruit consist of well grown specimens of one variety, sound, of not less than medium size and of good colour for the variety, of normal shape and not less than ninety per cent. free from scab, worm holes, bruises and other defects, and properly packed:

(c) "No. 2" quality, unless such fruit consist of specimens of not less than nearly medium size for the variety, and not less than eighty per cent. free from worm holes and such other defects as cause material waste, and properly packed.

Section 7. No person shall sell, or offer, expose or have in his possession for sale, any fruit packed in any package in which the faced or shown surface gives a false representation of the contents of such package; and it shall be considered a false representation

when more than fifteen per cent. of such fruit is substantially smaller in size than, or inferior in grade to, or different in variety from, the faced or shown surface of such package."

SOME PACKING TERMS DEFINED

Face layer.—The apples first packed in the barrel.

Tail or crown layer.—The apples last packed in the barrel; the tail or crown layer should extend about an inch and a half above the chime to allow sufficient compression in heading to make the pack firm.

Barrel head.—Either end of the barrel.

Chime.—The edge or rim of the barrel formed by the projecting ends of the staves.

Pack.—A standard, definite uniform arrangement of apples in a market package. The term generally applies to boxes.

Straight pack.—A box pack in which the apples in a layer appear as in Fig. 11.

Diagonal pack.—A box pack in which the apples in a layer appear as in Figs. 7, 9 and 14.

Offset pack.—A box pack in which the apples in a layer appear as in Fig. 13.

Alignment.—The arrangement of apples in the box in such a way that they are in straight lines however viewed.

Bulge.—The convex appearance of the finished pack. The flexible box bottom is sprung in nailing and when the box is in the press half the bulge is taken by the top. The spring of the top and bottom takes up the slack in transit and storage and keeps the pack firm. (See Fig. 15)

Height of ends.—The height of the pack at the ends of the box. The filled box will have a bulge, but the ends of the surface layer must be flush with the box top. If the fruit is too low the pack is slack, if too high the end apples are crushed.

Tier.—The approximate number of apple diameters across the box from side to side. See Figs. 7, 9, 11 and 13.

Style of pack.—"3-2," "2-2," "3-3", etc. In considering the styles the term "3-2" refers to the start of the first and similar layers. Three apples are first placed then followed by two. These successive placings designate it a "3-2" pack. Likewise with the "2-2," "3-3," and "2-1" styles.

PURDUE UNIVERSITY
Agricultural Experiment Station

Circular No. 40

LaFayette, Ind., September, 1913

AGRICULTURAL EXTENSION
XIX

UNIVERSITY OF ARIZONA
LIBRARY

REPORT OF POULTRY CONDITIONS IN INDIANA

By A. G. Philips
Division of Poultry, Department of Animal Husbandry



Fig. 1. The Purdue Experiment Station Poultry Farm. Note how the yards contain both fruit trees, rape and corn as well as chickens

In the summer of 1910 the Division of Poultry in the Animal Husbandry Department of the Purdue University Agricultural Experiment Station, was made a fixture, and the first thing done was to get a collection of data regarding the conditions of poultry as

they existed in Indiana. Lists of questions were sent out to two thousand farmers and this circular is a summary of the answers received from the people of the State telling how they viewed conditions. The object of this circular is to show the conditions of poultry in Indiana as told by the farmers of the State. The conditions will be discussed and recommendations made for improvement.

The poultry business is one of details and is, on the average, but a side issue on the farm. A weekly cash income is a desirable feature; fresh eggs and meat are good food that can be obtained largely from waste products; the work is something that can, and is easily handled by the women on the farm, and the investment required is small. All these things combine to make the poultry side of the farm, both profitable and desirable.

Few people appreciate the total value of the poultry business, or know what a loss of income there would be if it was removed from the list of farm products. It is not a "get rich quick" proposition, but one of the small things that count up in a year's time. Many a housewife finds that her only source of income for food and clothing is from the sale of eggs and chickens. These things make the hen indispensable.

STATISTICS

Statistics are often considered dry and uninteresting but it is only by them that the financial value may be shown. Those that are collected do not, however, show the real value of the chicken business, for none of the thousands of hens and the hundreds of thousands of eggs produced inside of town and city limits, are ever considered. The following figures are quoted from the Fourteenth Biennial Report of the Department of Statistics of Indiana for 1911-1912. In order to show the great increase in the production of eggs, thereby showing the increasing interest and importance in Indiana, the following are given.

No. dozen eggs produced in 1910...68,672,724
No. dozen eggs produced in 1900...38,987,348

Increase 29,685,376 or 76 per cent.

1911

No. poultry sold.....7,425,144, value $3,146,143
No. laying hens on hand.....9,530,220, " 3,938,933
No. ducks, turkeys, geese, on hand 209,604, " 124,973

Total$7,210,049

Average value per bird, 42 cts.

No. dozen eggs produced.....69,690,104, " $13,130,407

Grand total$20,340,456

Average value per dozen, 18 cts.

Average egg production per hen, 87.7 eggs

THE FIVE LEADING COUNTIES IN POULTRY SOLD IN 1911

White	146,328 birds
Allen	139,944 birds
Adams	135,228 birds
Kosciusko	127,740 birds
Cass	126,240 birds

THE FIVE LEADING COUNTIES IN LAYING HENS, 1911

Kosciusko	211,980 birds
Allen	185,976 birds
Jay	168,768 birds
Randolph	167,196 birds
Adams	166,932 birds

THE FIVE LEADING COUNTIES IN EGGS PRODUCED IN 1911

Kosciusko	1,513,071 dozen
Allen	1,431,273 dozen
Ripley	1,232,980 dozen
Jay	1,224,507 dozen
Grant	1,214,774 dozen

EGG PRODUCTION DEPENDS ON FOUR THINGS

Egg production depends on four things and if any of these four be absent, maximum egg production need not be expected.

1. The hen must be bred to lay, that is she must have that invisible inheritance that gives her capacity and ability to lay. Some people call this "an inborn tendency to lay." This means that the breeding will have more influence than the breed. *Breeding surely tells.*

2. The hen must be physically strong enough to withstand the drain of heavy egg production, and the chances of disease. She must be able to withstand the abuse that man generally gives her by making her environment unnatural, be able to lay a large number of eggs when prices are high, and produce hatchable germs when the incubation season arrives. Constitutional vigor is of first importance, and though the hen be well bred and every environment be exactly right, if she has some physical weakness that is either hidden or apparent, the results will be unsatisfactory.

3. The hen must have suitable environmental conditions such as housing, yarding, condition of range, etc. The house is the home of the hen, and as such should be comfortable. Dampness, draught, and poor ventilation, all retard egg production. A small yard or bare range is not conducive to success.

4. The hen makes eggs out of the food given. She depends upon it and must have it in large enough quantities to induce rapid growth and large production. A hen can not lay well on just any food that may be given. This has been demonstrated too many times on the farm and at experiment stations.

Egg production is one of the chief aims of the poultry raiser, and it is for this reason that these four things are mentioned. They are given in the order of their importance. The bird itself must be the first consideration.

The answers to the questions sent out, tell the truth of conditions better than anyone could give them and the ones that were answered are now taken up in proper order.

ANSWERS TO QUESTIONS—704 REPLIES

Extent of Business

Q. 1.—Is your poultry kept for a livelihood?

Yes 101
As a side issue..... 568
Both 35

Q. 2.—Do you keep poultry to produce fancy eggs for hatching? Yes, 122
For breeding and show stock? Yes, 82
For eggs and poultry for market? Yes, 608
For home use only? Yes, 20
Mentioned twice, 129

Q. 3.—Which of these branches is your most important line?

Eggs and poultry for market.... 422
Poultry for market..... 120
Fancy poultry 36
Hatching eggs 21
Home consumption 25
Capons 1

From these figures it is easy to see that the market side of the question is the most important phase of farm poultry. A few people find it profitable to sell stock and eggs for fancy purposes, but the commercial side is by far the most popular with the farmer. Poultry is a side issue on the farm and a part of diversified farming, but there seems to be a rapid growing sentiment to make the hen have a more important position than she has had in the past. This is proven by the statement that 101 out of 704 keep poultry as an important means of livelihood.

Kind and Amount of Stock

Q. 4.—How many chickens have you?

113 have 100 fowls
93 have 150 fowls
82 have 200 fowls
1 had as few as 11 hens
40 have over 300 fowls
1 man keeps 1500 fowls

Total birds 94,589, or an average of about 134.5 fowls per farm

Q. 5.—Are your fowls pure bred?

Yes	313
No	270
Partly	117

Q. 6-7-8.—What breed or breeds do you keep?

Plymouth Rocks	459
Leghorns	165
Rhode Island Reds	100
Wyandottes	57
Orpingtons	41

Nine other breeds each with a few admirers were reported

Q. 9.—How many have you over two years of age?

None	344
From 3 to 25	187
From 30 to 150	81
Do not know	14

The farmer has but little money invested in poultry stock, according to statistics. Each bird is worth on an average of 42 cents and with the average number at only 134.5, the farmer's average investment in fowls is only $56.49. It is gratifying to know that about half of the birds are pure bred.

The Plymouth Rock is the popular farm fowl. It seems to suit the average needs of the farm. It is surprising to see the number of Leghorns in Indiana, for on the farms where five hundred to fifteen hundred were kept, the Leghorn is very popular. Another sign of good poultry raising was shown by the small number of people that kept birds over one year old.

It is not generally advisable, except with Leghorns, to keep a bird for egg production over eighteen months from the day it is hatched. A chicken does its best laying in the twelve months after it lays its first egg. Mature yearling hens are best, however, as breeders and should be held back from early winter laying in their second year, and not expected to do much until in February. Pullets are the best layers but not the best breeders. This makes hens expensive to keep just for market eggs, but for breeders they will pay well for their feed and trouble, in increased fertility and strength of germ. With Leghorns, it may pay to keep them until over two years of age just for market eggs, for they do not get over fat as easily as do heavier breeds. It will not pay to sell a Leghorn at one year of age. If bought for a breeder she will cost around $1.00. As a hen, sold on the market, she may bring 40 cents. This 60 cents depreciation is too great on one year's investment, but if divided over two years it is not so great. A Plymouth Rock pullet costing $1.00 may sell for 85 cents in July as a hen on the market. The loss would then be but little. A mature, tried and physically strong hen is a better breeder than an immature pullet. It is advisable to

select a breeding pen each fall; give the birds free range away from the growing pullets and let them rest until February. The pullets can then be forced for egg production. If it is necessary to confine any birds, the breeders should not be confined; they should always be allowed the freedom of range.

On the farm it is not always practical to leg band hens in order to keep record of their ages. It entails too much labor. An easy way has been suggested, of marking with round hog rings, putting one on the right leg of a bird when one year old and then adding another when two years old. Thus any person may easily tell the ages of the birds without catching them.

Selection or Breeding

Q. 10.—Do your fowls seem to decrease in vitality the longer you breed them?

Yes 265
No 193
Not until later.... 68
Do not know..... 46

Q. 11.—Do you exercise any care in selecting poultry for breeding purposes?

Yes 506
No 76

Do you select breeders for meat or egg type? Yes, 58
For egg type? Yes, 175
For both meat and egg type, 324
Do you exercise care to prevent inbreeding?
Yes 551
No 73
Do you buy new males each year?
Yes 502
No 142
Do you improve the fancy show qualities of your stock?
Yes 226
No 276

These answers are interesting. The evidence is in favor of selling the hen when past her year's laying period, for then she decreases in vitality. There is some inconsistency in the answers to question 11. Nearly half of those answering, endeavored to improve the fancy qualities, breed for dual purpose, prevent inbreeding, and buy new males each year. For the farmer, this is an easy and apparently a practical way of keeping up his breeding stock, but if the real fancy points are to be obtained, buying new males each year will soon defeat the end desired. Strange blood lines do not always mix well together, and so cause apparent outbursts in the offspring of all the undesirable features possible. If fancy breeding is done, close blood lines must be adhered to.

The dual purpose hen is liked the best. The farmer wants a hen that will lay fairly well, have a heavy body and produce chicks

with a maximum amount of edible food. Care is given in selection of breeders as it should be, and vitality is apparently kept up by buying new males each year. Inbreeding is abhorred for it is thought that it may cause weakness. This buying of new males makes a profitable business for the fancier, and the fact that the birds are pure bred keeps up the interest in the poultry flock.

When the figures are carefully analyzed there is found that ten or more per cent. of the people pay no attention to breeding or improving the stock in any way. They want the hens to be profitable but they do not want to give the necessary amount of attention.

GOOD BREEDING IS IMPORTANT

The inherited qualities are the basis of success with poultry. When chicks do not hatch or live, or hens lay few eggs, the average cause is some weakness in the parent birds. It may be in the blood lines. Maybe the ancestry or inheritance is not what it should be. On many farms it would pay to invest in some breeding stock of



Fig. 2. A young male with strong vigor. Note width of breast and spread of legs



Fig. 3. A young male of weak vitality. Note narrowness of body and tendency towards knock knees

known ancestry; stock that has been known to produce eggs and transmit those qualities to the offspring. If the ability to produce eggs was dominant in the breeding of the males they would stamp that quality on the offspring. A few dollars invested in this manner would pay.

The greatest influence that breeding possesses is shown in the vitality or constitutional vigor. If an egg fails to hatch, the blame is too often placed on the incubator or setting hen, or maybe on the male heading the flock. The hen plays her part in causing poor hatches, for if she is weakened in constitution by poor housing, cured or present disease, or heavy laying, the chances are slight for her to transmit strength to the germ in the "hatching egg." This likewise applies to the male. At Purdue Experiment Station, a pen of White Wyandottes one year did not produce a hatchable egg. Two Silver Laced Wyandottes were later placed in this pen and ninety per cent. of their eggs hatched. The White Wyandottes still failed to produce chicks. The same results were found in a pen of Black Orpingtons where Black Langshans were introduced. In both of these pens all hens were known to have been mated. To a student of poultry, the cause of such a condition ought to be discovered. No one seems to be able to find out why eggs will not hatch. One thing is sure; the cause in these cases did not all lay with the male bird.

Another instance is of interest. On a certain farm one season, the hatching was splendid; as good as could be desired. That fall, roup broke out on the farm and the following spring the hatching was miserable. The winter conditions had been first class and the only cause that could be attributed was the weakness in vitality due to the roup of the preceding fall.

At Purdue, hens as a rule do better than pullets, in producing strong germs. The eggs of lighter breeds always hatch better, regardless of the means of hatching, than do the heavier ones. Some hens never produce fertile eggs, while others always have exceptionally high fertility. Birds confined, lose their health quicker than those running on range. They do not keep in good condition. Experiments show that vitality is the influencing factor in the above mentioned cases; it can not be anything else. When that ofttimes hidden something called vigor, is well defined and understood, then can many of the troubles be prevented.

Vigor has its influence in preventing disease. Immature stock is more susceptible; mature stock seems many times to be immune, and some birds never show signs of disease under the worst of conditions. They are not susceptible; they are stronger in health and have greater vigor.

Housing and Yarding

Q. 12.—What is the shape of your house roof?

Shed	355
Gable	255
Combination	48
Hip	10

Material used in floor construction

Earth 358
Concrete 105
Boards 135
Gravel 40

Method of ventilation

Windows 142
Windows and doors 89
Open front with muslin covered frames.. 54
Cracks 54
Doors 49
Holes in gables or roof..... 85
Open front 39
Flues, etc. 36
Nothing 35

Q. 13.—Is your house satisfactory?

No 332
Yes 276
Fairly so 60

Q. 14.—Is your stock allowed range?

Yes 669
No 23

Practically all have unlimited range on blue grass, clover and other grasses.



Fig. 4. A type of house too common on Indiana farms. This house is too high in front, full of cracks and very dark; has no foundation or floor and hence is damp and unhealthy; even a window would have made an improvement in this house

For some unknown reason a large per cent. of farmers thinks that the gable or "A" roof the best, when it is far more expensive to build than the shed or flat roof. It is unnecessary to build a hen house high in the rear. The hen needs little air space and the height in back must be controlled by the head room needed. The gable roof has the same height both front and rear. Five feet is high enough for the back of an ordinary house. In traveling over the country a person sees many houses ten or twelve feet high, necessitating enormous waste of lumber.



Fig. 5. An improperly built hen house. The owner of this house spent $60.00 for material and then made it so tight and dark that it was of little value

The floor of a house must be dry and sanitary. A dirt floor is never sanitary; a concrete floor costs more, but a board floor is no cheaper. One thing must determine the floor, and that is cost. If the money is available to put in a floor, a concrete floor can be made dry, everlasting and sanitary. There are too many cracks in a board floor. A concrete floor if properly made will not be damp, and the litter will prevent coldness causing any trouble. Dirt should never be used if the money is available for putting in concrete.

The figures on ventilation are amusing, for such a thing is secondary with most people. Many a person has spent money building a house that allowed the sun in through windows, but was so tight that it would not let the dampness and bad odors out. Some houses even have no light in them. A poultry house should be dry,

have plenty of fresh air in it, and no draughts. These principles prevent the use of cupolas, flues, cracks, gable windows, etc., as a means of causing rapid ventilation. Some of the schemes mentioned above might be advisable in the hot weather, but never in winter when hens need protection badly.

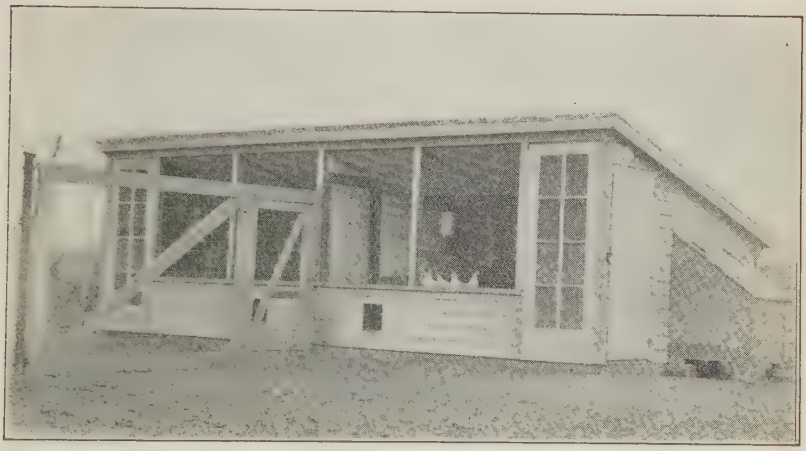


Fig. 6. Open front poultry house. The poultry house is the home of the hen

A house tight on three sides, floor and roof, may have little or much open space on the south side, according to the number of birds and size of the house. Part of this opening should be covered with glass and part of it with muslin covered frames, that can be raised or lowered to suit conditions. Purdue Circular No. 37, on "Housing Poultry" is available to those who send for it. It is easily seen that the kinds of roof, floor, and ventilation are unsatisfactory as shown by the answers to the question—"Is your house satisfactory?" Evidently it is not, and the farmer knows it. Since "knowledge is power" why do not they rebuild? Some of them are rebuilding, but still more either have not time, or do not think it worth the trouble.

The hen of Indiana runs at liberty over the fields and pastures, the best place possible. She can make eggs and profit out of the waste.

Feeding

Q. 15.—What do you feed your chickens?

Grain only, such as corn, wheat, oats and barley...315
Grain and mill feeds such as bran and shorts....182
Grain and milk or meat scrap..... 86
Grain, mill feeds and meat scrap or skim milk.... 71



Fig. 7. Interior of poultry house showing raised roosts, and trap nests on wall. If nests are not placed under dropping boards, but are placed on the wall, they should be so constructed as to prevent hens roosting in them. Note hood in roosting quarter

Many fed grit and shell with the above feeds, and a few fed different combinations from those mentioned. Cooked potatoes were a very popular food and some thought it advisable to feed tonics. Every conceivable method was used in feeding and all possible amounts were given. Some fed regularly, and some never fed any-



Fig. 8. Interior of poultry house showing platform on which are placed all feed and drinking vessels. This keeps everything up off the floor, insures cleanliness and prevents wasting

thing at all, so it is hard to classify the method, time and amount of feeding.

Some just criticism can be made of the average ration and method of feeding poultry, on the farms of Indiana. As indicated in the figures above, half of the people of the State rely on grain alone as a means of supplying food for maintenance, growth and egg production. A considerable number go farther than this and add some mill by-products such as bran and shorts. Only a small proportion adds meat scraps, skim milk or green, cut bone to the list of feeds that their hens receive. In examining the monthly records submitted to the Poultry Department by farmers of the State it is found that where Leghorns, Plymouth Rocks, Wyandottes, or Rhode Island Reds were fed grain only, the average egg production

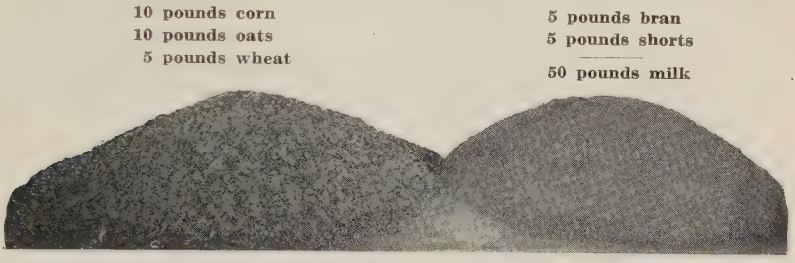


Fig. 9. A laying ration

If milk is not available, use three and one-half pounds of meat scraps. Feed the mash in a hopper, the grain in the litter, and the milk in a pan; see that they are all consumed in the same length of time

ran from 52 to 70 eggs per hen per year. Where mill by-products and meat scraps or milk were added to this grain with these same breeds, the minimum production was 66 eggs per hen and the maximum 124. Most of the flocks fed in this manner averaged over 85 eggs.

SOME WORK AT PURDUE

At the Purdue Experiment Station there has been carried on for the past two years an experiment with Leghorn pullets in which all pens were fed corn, wheat, and oats, bran and shorts in the same proportion. To Pen No. 1 there was added ten per cent. meat scraps. To Pen No. 2 was added enough skim milk to equalize the amount of protein contained in the meat scrap of Pen No. 1. In reality this meant about as much milk as the chickens would drink. In Pen No. 3 no meat food in any form was given. In looking over the results of this two years' work the following averages per hen per year are found:

Egg production, meat scrap pen.....	135	eggs
Egg production, skim milk pen.....	133.5	eggs
Egg production, no meat food pen.....	36	eggs

The cost of feed per hen

Meat scrap pen.....$.915
Skim milk pen..... 1.085
No meat food pen..... .73

In the pen receiving milk the egg production through the winter months of December, January and February averaged almost seven per cent. greater than the pen fed meat scrap. The question arises from this as to the food value of meat scraps, and skim milk for hens. When comparing Pen No. 1 with Pen No. 3 it is found that for every $2.50 invested in one hundred pounds of meat scraps there was $24.20 return. In Pen No. 2, for every 30 cents invested in one hundred pounds of skim milk $1.73 was returned. These figures certainly indicate that the purchase of skim milk or meat scraps is a paying investment for hens. The birds fed these rations were properly housed and each allowed the freedom of a yard 150 feet by 150 feet of cultivated land. A fuller description of the ration fed can be found in Purdue Extension Bulletin No. 10.

Hens are naturally grain eaters and should have a large amount of grain in the ration, but grain alone will furnish the hen with very little besides fat, heat or energy and the yolk of the egg. In order to furnish a feed which will make the flesh, blood, tendons, skin, feathers, and white of the egg, it will be necessary to resort to the feeding of mill by-products, such as bran and shorts and either meat scraps, skim milk or something of that nature. The above experiment clearly demonstrated this, as do the egg records of farmers scattered over the State. Many people feel that it is unwise to spend money for feed for hens, but if $2.00 or $3.00 can be made by investing $1.00 in milk, or by buying tankage to feed the hogs and giving the skim milk to the hens, it is a paying proposition. If the average farm ration of corn was supplemented by hoppers filled with bran and shorts and troughs or pans filled with skim milk, egg production would increase. A hen can not lay an egg unless she has the food with which to make it. Grain alone can not make many eggs.

Hatching and Rearing Chicks

Q. 19.—Do you use an incubator?

Yes 263
No 437

What make? Forty-eight different kinds of machines were reported, of which the majority are the cheaper hot water incubators. Quite a number use the higher priced hot air machines. No one particular machine predominates over another.

Q. 20.—Which do you prefer for incubation, hens or incubators?

Hens 337
Incubators 160
No preference 42
No experience with machines.. 92

Q. 21.—Do you use a brooder?

Yes 192
No 442

What make? Most farmers use the small fifty to one hundred chick size brooder, many of which are home-made.

Q. 22.—Which do you prefer for brooding, hens or brooders?

Hens 358
Brooders 109
No experience with brooders..117

Q. 23.—Do you have any trouble with brooders?

Yes 94
No 111
No experience....146

A large majority of those who use incubators, like them because they are easy to regulate and seem to get desired results. It is claimed that an incubator is less trouble than a large number of setting hens, and that the time of hatching can be absolutely controlled by an incubator, but not by hens. The hen, however, is still the most popular because it is believed that she is the natural incubator, will hatch more chicks and assure greater health and vitality in those that hatch. Some people even think the hen is less trouble than the incubator, for no lamps have to be filled, eggs turned, etc. Since poultry problems generally fall into the hands of the busy housewife, it is necessary that the amount of labor be reduced to a minimum. This means that an incubator may be impractical. It is a pretty well known fact that an incubator is necessary where a large number of chicks are hatched, especially if they are wanted early in the season. The lice problem can be greatly reduced, and the care of handling a bunch of fussy hens avoided. There is a feeling, however, that incubator chicks are more apt to die than hen hatched chicks and this is not altogether without foundation. Some people think that it is absolutely necessary to raise breeding stock from hen hatched chicks. While hens are very popular as incubators, they are still more popular as brooders, because it is believed that hens will give a more uniform and natural heat and can take care of the chicks when the caretaker is busy with other things. The use of the hen as a brooder is largely a matter of whether or not labor is available for the care of the brooder. The advocates of the brooder say that there is more room



Fig. 10. Cornell gasoline colony brooder. In use on Purdue Poultry Farm; will handle two hundred chicks easily and can be used the year round



Fig. 11. Rear view of Cornell gasoline colony brooder house showing gasoline tank, pipe to burner below, and pipe for waste heat

for the chicks, better heat which can be easily controlled, and that a large number of chicks can be taken care of at one time. Many people have a hatred of tending several hundred chicks that are in the care of a large number of fussy hens, for some hens are good mothers and others are extremely poor ones. Those who have used brooders and like them, claim that a person always knows where



Fig. 12. Interior of Cornell gasoline colony brooder showing hover ready for use; gasoline tank is overhead

the chicks are, that it is less trouble to care for them, and that those raised are better and stronger than the hen raised ones. Those who have had bad luck with brooders claim that the lamp goes out easily, that it is hard to regulate the heat, it is too much work to care for them, and they influence weakness and cause rheumatism in the chicks.

At the Purdue Experiment Station good results have been obtained from brooders where the proper kind was used. The best results have not been obtained from lamp heated brooders, but no better possible results could be obtained than when the colony

brooder house was used, heated by a gasoline burner. This brooder is an 8-foot by 8-foot colony house 6 feet 6 inches high to the comb, with an "A" shaped roof, placed on runners so that it can be moved from place to place without much trouble. It is patterned after one put out at Cornell University, and heated with the same kind of a gasoline burner. The lumber and material for such a house will cost in the neighborhood of $15.00. The heater costs $11.00, and the cost of labor will depend largely upon local conditions. It



Fig. 15. Interior of Cornell gasoline colony brooder showing hover raised, exposing heater box

will take from thirty to forty-five hours of an ordinary man's time to build the brooder. It will handle two hundred to two hundred fifty chicks very easily up to broiler age, at which time the cockerels should be removed and sold and the pullets allowed to remain. When the time arrives to remove the heat, the hover should be removed, roosts placed inside, the house moved to corn field or orchard and the chicks allowed the freedom of the fields. By this method the labor in handling a brooder is greatly reduced. There

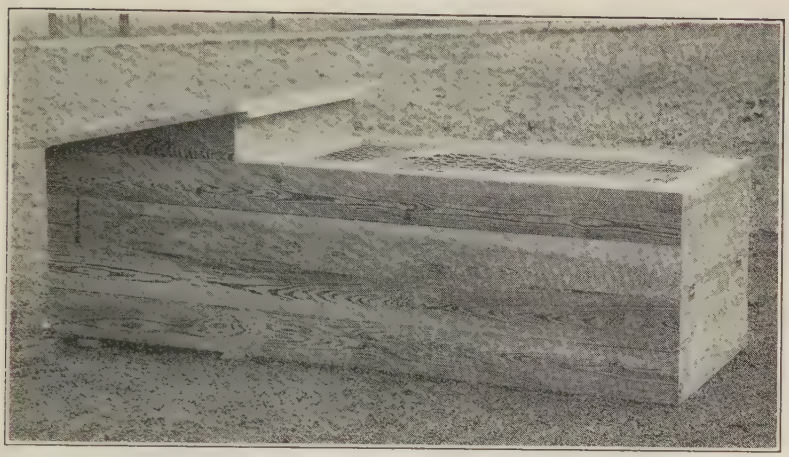
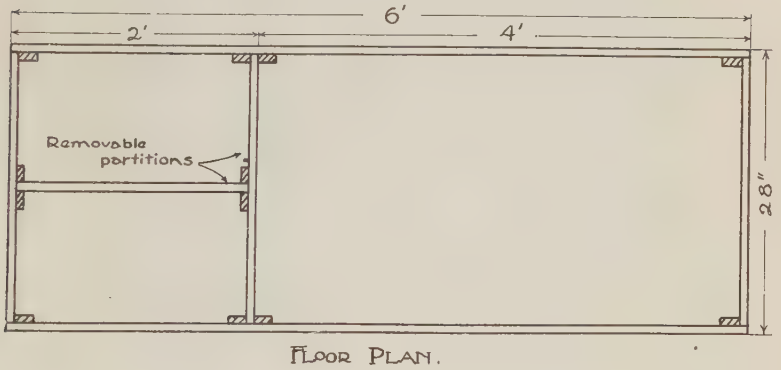
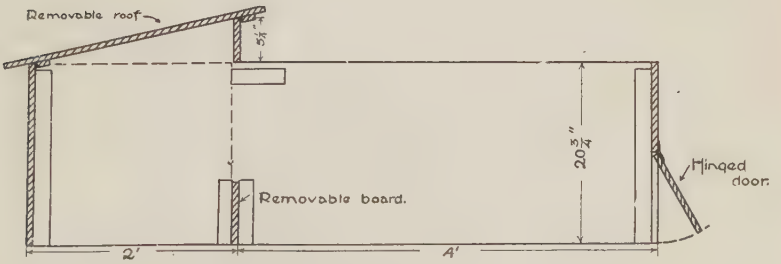


Fig. 14. Side view of hen brooder showing lid closed and wire top in position



FLOOR PLAN.



SIDE ELEVATION.

Figs. 15 and 16. Working plans for hen brooder

are no wicks to trim, the tank needs filling but once a week, and the investment is in use the year around. When winter comes and it is time to dispose of or separate the chicks, the brooder is very handy in caring for surplus birds or as a breeding pen for a dozen fowls.

Diseases and Parasites

Q. 24.—Do many of your little chicks become affected with so-called white diarrhoea?

Yes 210
No 376
Very few 85

Q. 25.—Do you have any trouble raising little chicks?

Yes 376
No 270

What are the troubles?

Gapes 171
Lice and mites.....100
Diarrhoea 90
Hawks and crows.... 42

A large number of other unknown troubles were reported.

Q. 26.—How do you destroy the poultry body louse?

Insect powder ...210
Spraying 152
Dust bath 65

Quite a number used various other schemes, such as greasing with lard, burning sulphur in the house, using louse machines, patent louse killers, hot soap suds, white wash, etc.

Q. 27.—How do you destroy the poultry mite?

Spraying and painting roosts with kerosene....166
White wash 81
Spraying with carbolic acid and coal oil..... 76
Prepared coal tar dips 70

The remainder used various schemes such as tree sprays, lime, kerosene emulsion, etc.

The problem of dealing with the trouble which apparently affects about half the chicks, that is commonly known as white diarrhoea, is hard to explain and solve without each case being taken up individually. Purdue Extension Leaflet No. 25 is on the subject of diseases of chicks, and gives a description of the indications of the truly infectious white diarrhoea. The Connecticut Experiment Station at Storrs, Conn., has done more work than any other station on this subject, and its more recent bulletin states that it is believed that bacillary white diarrhoea may be prevented by

starting young chicks on sour milk as a drink. This should be given them when the first liquid would ordinarily be supplied. It must be remembered that all diarrhoeas are not caused by specific organisms, but may be caused by improper care, weakness in vitality, careless feeding, crowding, chilling, etc. There is only one way to tell whether or not young chicks are affected with bacillary or infectious white diarrhoea and that is by making a post mortem examination. If chicks are so affected, their livers should show congested areas of bright red either in streaks or apparent spots. The crop and intestines will in all probability be nearly empty or



Fig. 17. A white diarrhoea chick. Note the sleepy, dumpy condition and tendency to "paste up" behind

filled with a slimy fluid. The unabsorbed yolk is nearly always present. If these conditions are not apparent, the trouble is caused by the management and can be handled accordingly. If these indications are found, the chicks that are affected had best be killed, and their carcasses burned. Every care should then be taken to prevent the spreading of the disease by the most careful disinfection, and an abundance of sour skim milk given to the chicks that are unaffected. The organism that causes this disease has been found in the ovaries of the hen that lays the egg, and it may therefore be necessary to go back to the source of the infection in order to prevent its development in the future.

It is very apparent that people have trouble in raising their chicks, and the majority of them find the gape worm a big nuisance.

The eradication of the gape worm is very easy when its life history is once known. The gape worm lives in the soil. Its eggs may be eaten by the chickens or angle worms. The hens or chicks may eat the gape worm or the angle worm. In any case the eggs may hatch and the young or mature worms work their way into the trachea or wind pipe of the bird. Here they attach themselves by one end to the wind pipe and if the numbers be great enough they will prevent the passage of air into the lungs and tend to suffocate the chicks. There are several gape remedies on the market and there are a good many old time methods of eradication, such as the horse hair, the stripped timothy head and others, but the easiest plan is to take the chickens on to clean and sweet land and destroy the worms in the old soil by plowing and cropping. So-called "gapey land" should be limed and sprayed if possible, then plowed and planted down to a growing crop. In two or three years the chicks can then be returned to it, for the land will be free from the gape worm. Crops of young chickens should be moved from one place to another from year to year. It is never advisable to have any particular piece of land used for chickens only. Orchards, corn fields or pastures all make ideal places to raise or keep poultry and at the same time raise a crop. They will supply the birds with the needed food and clean land. If the gape worm gets started, keep the coops sprayed, the drinking water antiseptic by the use of enough potassium permanganate in it to make it claret red, and remove the chicks to new land.

It is interesting to note the variety of schemes suggested for the eradication of the body louse. The louse lives and reproduces on the body of the hen, and it seldom leaves its host. It has biting mouth parts, and lives on the scurf of the skin and base of the feathers. It can not suck blood. As a rule it may be found in large numbers in the filth that collects below the vent. Lice do not reproduce in the cracks or crevices of the house, and they are seldom found on the roosts. Knowing these things it is easy to prepare a plan of eradication. Spraying the hen house will be but slightly effective, for if an odor is strong enough to go up through the feathers and kill all the lice on the hen's body, it will probably be strong enough to injure the hen by affecting her breathing. Lice breathe through the pores of their bodies. They have no nasal organs, but if these pores can be filled with dust they are easily suffocated. Thus the use of purchased or home made louse powders, dusted on to the hen will kill most of the lice that are on her. If this is used it will be necessary, however, to repeat it in from ten to twelve days in order that the nits or eggs that have hatched may then be destroyed. Some people have found it advisable to dip the hens in a weak solution of coal tar dip in the warm summer or early fall. This is very effective but requires repeating in from ten to fourteen days. At Purdue Experiment Station an easy and practical though an ofttimes unbelievable method of eradicating the

louse, has been used satisfactorily. This remedy is called "blue ointment," a mercurial compound that is of course very poisonous. This blue ointment can be bought at drug stores, but the purchaser should insist that it be fresh and not exposed to the air, which causes oxidation and the reduction of strength. Blue ointment is a salve, and a small amount of it, about the size of a pea or less, should be applied to the skin of the abdomen just below the vent or anus. One application of this, well rubbed over the skin will remove the lice and keep them off for from six months to a year. The main thing to watch for, is to avoid using too much, for wherever blue ointment is used there is danger of mercurial poisoning. With the directions followed as given above, there will be absolutely no trouble in its use, but there certainly will be a great relief to the poultryman in the reduction of labor and eradication of lice. It is not advisable to use blue ointment on little chicks or setting hens. If it is applied to the laying hens in the winter time there will be no need of its use in the hatching season. If setting hens are lousy they will have to be powdered. If hens with little chicks are lousy they should be powdered, or a small amount of blue ointment applied to the hen.

It is very apparent that there is plenty of the proper information regarding eradication of the poultry mite. Mites live and reproduce in the cracks and crevices of the house where filth predominates. They have sucking mouth parts and live on the blood of the hens which they obtain when hens are roosting, setting or laying. In order to eradicate the mite it should be covered with a strong spray. Many of the orchard sprays will be satisfactory, or coal tar stock dips mixed about one to thirty-five, to which may be added one-half part crude carbolic acid, will surely do the work. These are the easiest methods to be used by the farmer. Any strong disinfectant should destroy mites.

Management

Q. 28.—Do you allow your old and young chicks to run together?

Yes 480
No 211

Q. 29.—Do you cull closely, discarding all fowls you think unprofitable?

Yes 476
No 86

Q. 31.—Do you separate males from the flocks except during the breeding season, for the purpose of securing infertile eggs for market?

Yes 74
No 617

If not, why not?

Too much trouble	160
Never thought it necessary	53
No place to keep separated males	59
Does not pay	58
Market does not demand it	18
Other reasons	65

Those who keep poultry, as a rule follow the line of the least resistance. They think it is too much trouble and apparently does not pay to separate growing chickens from the older birds. This attitude is radically wrong, for it is absolutely impossible to feed laying hens and growing chicks properly on the same feeding ground. The older hens bother growing stock considerably and prevent them from growing normally. Many people insist on keeping a lot of useless roosters on their farms throughout the year. The presence of the male bird is unnecessary for the production of eggs, and the roosters eat some feed throughout the summer and fall months that some growing pullet could use profitably. The presence of the male bird insures a large number of fertile eggs, which are easily affected by the heat of the summer months. During these months there are a large number of eggs marketed, and an appalling per cent. of them are found to be spotted and containing live or dead germs. Since nearly all eggs are bought at so much per dozen regardless of their quality, it is necessary that the average price be reduced on account of the large number of eggs containing developed germs. If all the old roosters could be sold or penned up about the middle of June every year, there would be better eggs on the market and fewer bad ones reach the consumer. The Government has recently published Bulletin No. 160, Bureau of Animal Industry, on the "Care of the Farm Egg," which shows conclusively that infertile eggs are by far the most profitable to market. It is never too much trouble to sell old roosters if there is money coming in to pay for it. Fertile eggs can not stand the heat of the average July or August and reach the market or the consumer in the best of condition.

Q. 33.—Do you believe your fowls pay you well?

Yes	462
No	80
Fairly	130
Do not know	4

Q. 34.—If not, why not?

Lack of attention, neglect, mismanagement	72
Ignorance	9
Numerous other causes such as poor feeding, high cost of feed, etc.	30

Q. 36.—Do you think you should get a better price for your eggs and poultry than you do?

No 380
Yes 154

Q. 37.—If your buyer should pay you a premium for first class eggs and poultry, would you take more care and furnish better goods?

Yes 311
No 89
Take utmost care now 153
Possibly 34

Q. 38.—Would you join and help a cooperative association for marketing poultry and eggs?

Yes 305
No 120
Doubtful 158

Q. 39.—What do you think is the main reason farmers do not get more money out of poultry than they do?

Lack of care, attention and management..361
Neglect and ignorance 73
Poor equipment 58
Lack of time 54

Various other causes of minor importance were given.

Q. 40.—Are you satisfied with your present methods of handling your poultry?

Yes 211
No 418

A large majority of farmers are willing to admit that their present methods of caring for poultry are unsatisfactory and that the reason more money is not made, is due to their own lack of care or method of management. It is hard to understand why they do not think better prices would be advisable. This might possibly be explained by the fact that the questions were answered in December when the price of eggs was rather high, and people answered that question upon the basis of the prices quoted at that time of year, rather than upon the basis of the average price for the whole year.

There are about twenty-five farmers keeping records of their farms and sending them in monthly to the Poultry Department. Most of these people are making good money off of their poultry, even under present conditions. In looking over the average prices of eggs that they have received it is found that 23 cents is the maximum yearly average and 13.4 cents is the minimum, with a general average of 17½ cents to 18 cents. This is not enough

to receive in order to make the poultry business as profitable as it should be. This does not mean, however, that all farmers are losing money on their poultry as is shown by the following results obtained by people on four average farms throughout the State of Indiana.

FARM A—Average number of hens.... 78.9

Average price per dozen eggs	$.214
Average number dozen eggs per hen	4.39
Total income	$161.05
Total expenditures	41.24
Total profit[1]	119.81
Profit per hen	1.497
Value labor per hour	.57

These birds were Buff Orpingtons; were given grain and ensilage and allowed to get the rest of their feed from the farm.

FARM B—(This report is of the years 1911 and 1912 and each year is reported separately)

	1911	1912
Average number of hens	331.2	325
Average price per dozen eggs	$.173	.20
Average number dozen eggs per hen	9.24	8.86
Total income	$626.92	$702.43
Total expenditures	282.74	297.61
Total profit[1]	344.18	404.82
Profit per hen	1.03	1.21
Value labor per hour	.46	.56

These birds were Single Comb Brown Leghorns and were fed grain, dry mash, meat scraps, and milk.

FARM C—Average number of hens.... 139.1

Average price per dozen eggs	$.16
Average number dozen eggs per hen	10.28
Total income	$366.55
Total expenditures	84.56
Total profit[1]	281.99
Profit per hen	2.02
Value labor per hour	1.018

These birds were Leghorns with a few Plymouth Rocks. They were fed grain, mash and waste from the farm.

[1] See page 27 for definition of profit

FARM D—Average number of hens... 141

Average price per dozen eggs	$.148
Average number dozen eggs per hen	7.33
Total income	$272.81
Total expenditures	24.18
Total profit[1]	248.63
Profit per hen	1.759
Value labor per hour	.434

These birds were Plymouth Rocks and fed corn, silage and meat scrap.

In obtaining these figures, we take the total number of hens and divide it by twelve. The income from the eggs is divided by the total number of dozens of eggs laid in the year, in order to obtain the price per dozen. In finding the income the actual cash received for things sold and the value of products consumed were added to the increase in inventory. The profit is found by subtracting all expenses, excepting labor, from the income. This was divided by the average number of hens and the profit per hen thereby determined. The profit was divided by the number of hours of labor given and the pay for each hour's labor was thereby found. It is seen from these figures that a good income is possible from hens on the farm, and that where a good ration was fed a fairly satisfactory yield of eggs was obtained. The average farmer keeps no accounts. He does not know what his poultry is doing for him each year, and he therefore can not see the definite value of that part of his farm work.

If it is true that hens would make more money if better attention were given them, there is only one thing for the average farmer to do and that is to give better care. The fact that he is not satisfied, shows that half the battle for improvement has been won.

Marketing

Q. 41.—When do you market your eggs?

Weekly	359
Fast as produced	122
Irregularly	122
Twice per week	40
Daily	8

These eggs are largely sold through the storekeeper or huckster and very few to the consumer or commission man. They are carried to town mostly by wagon when the other trading is done.

[1] See page 27 for definition of profit

Q. 42.—When do you market your poultry?

Late in the fall after culling	221
As soon as marketable	191
When price is highest	10
No particular time	73
In the spring	55
In the winter	66

Through whom are these marketed?

Huckster	208
Store keeper	201
Commission house	140
Consumer	83

It is an evident fact that eggs are given more attention at marketing time than poultry and if it were not for the traveling huckster and the groceryman some farmers would have a hard time

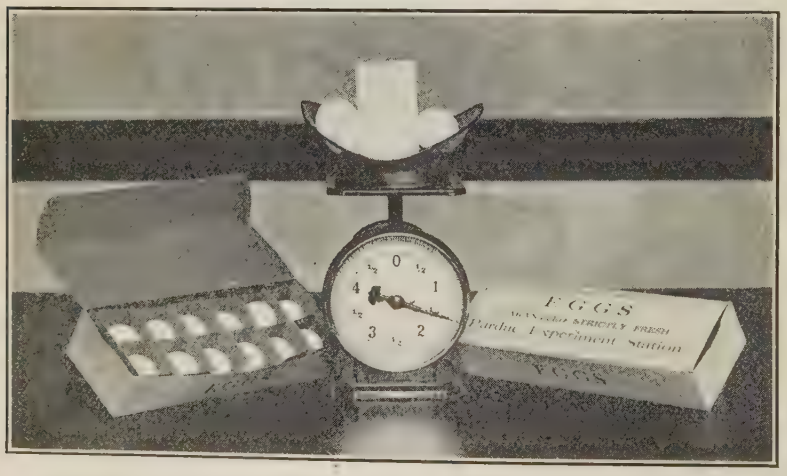


Fig. 18. One dozen eggs should weigh one and one-half pounds and be naturally clean and fresh; for fancy trade, paper cartons may be used. Farmers can increase the poultry profits by producing infertile eggs, grading them and selling them to special customers

getting any income from their poultry. The fact that such a large percentage of people market their eggs irregularly greatly influences the prices that are offered to the producer. Few eggs on the farm get the care that they need, mainly because people do not realize that it is as big a problem to get money out of a product after it is produced as it is to obtain this product. Throughout Indiana the average method of buying eggs is to pay so much per dozen regardless of quality. This prevents the farmer from having any desire to bring better eggs to market than his neighbor. It is very discouraging to farmers who would like to improve the quality of their eggs and place better eggs

on the market. Furthermore, it is unfair to those who do put good eggs on the market. When eggs are bought and sold on the quality basis, good eggs will bring a good price and poor eggs a poor price. This is as it should be. When the farmer is shown the influences that cause eggs to deteriorate between his farm and the consumer, he does not always feel like making an improvement because the buyer or commission man who controls the prices seldom pays him any more for good eggs than he does for bad ones. The average buyer seems unwilling to make a break to buy eggs on the graded basis as he fears that his competitor will not do likewise and the farmer not understanding the motive of this change of method, will take his eggs to the man who pays for them at a flat price. There are several ways of getting around this condition. One is by shipping independently to a better market than the local one, or second by cooperating with other people in the community and thereby making the amount and quality of product worth bidding for. A good plan is to urge the farmers to go together and demand that the local buyer buy on a different basis and pay according to grade and quality. Chicago, Indianapolis, Louisville, and Cincinnati pay better prices than the average small town. The difference is generally great enough to warrant making the shipment. In one small city of the State, a certain hotel pays 8 cents above quotations for strictly first class eggs. A Cincinnati grocer pays one farmer in this state 10 cents above the market price during nine months of the year, and 5 cents during three months of the year. If trips or correspondence were made to large cities it would be easy to find places where people want the best and are willing to pay for it. In examining the figures on the average prices of eggs paid farmers who have been keeping records for this department, it is interesting to note how one person averaged 14.8 cents per dozen in 1911 and by hunting for a better market obtained an average of 18 cents in 1912. In one town one farmer obtains 13.7 cents, and another farmer 17.2 cents per dozen. Several farmers close to large cities such as Cincinnati and Louisville obtained only 15 cents per dozen for their eggs in 1912. A suggestion was once made by this department to a farmer's wife, regarding the advisability of shipping eggs to Chicago, where at that time some people were obtaining almost twice as much for eggs as she was. In giving her reply this lady said that the "men folks" would not allow her to have a horse and buggy to drive a few miles to town twice a week to deliver eggs to the express company. If the man of this family had figured for a moment he would have found that the increase in price obtained from these eggs would have bought a horse and buggy and paid for its feed in one year. In this case the farmer was not foresighted.

Farmers seem to be the only men who are unorganized. They are struggling against other business organizations independently. They with their small resources, are endeavoring to keep up with business houses that have far more strength and backing. In Can-

ada cooperative organizations called "Egg Circles" have revolutionized the methods of marketing eggs and the prices received by farmers in different communities have been increased. The huckster who used to be the gatherer of eggs is now employed by the farmers to gather eggs for them at so much per dozen. They are organized with proper officers, stamp their eggs with their own number, send only the best quality to market, and because of the large number of eggs in one shipment, are able to command better prices in the larger cities, such as Toronto. This is the only method by which the farmer with a few chickens will be able to improve his prices, unless they are directly offered to him by the local dealers.

In marketing poultry a different but still worse condition exists. The average farmer sells his young chickens as well as old hens late in the fall or early winter, when prices are at their lowest. If the market quotations are studied it will be noticed that spring chickens are quoted in May, in such cities as Indianapolis, at around 30 cents. In June they drop to 25 cents and in October and November the writer has found prices as low as 9 cents per pound for nice broiling and roasting fowls in Indiana. It is not a difficult proposition, if the hatching season is controlled, to sell one and a half and two pound broilers in May. At that time, 50 cents could be obtained for a bird at a cost of from 15 to 20 cents. In the fall this bird would weigh not over five pounds at the most and if a Leghorn, not near that weight. Thus it would be hardly possible to obtain 50 cents for a young chicken in the fall of the year. Between this time and May a large amount of feed has been consumed and much labor required with no possibility of returning its cost to the farmer. Thus every one and a half pound chicken that was marketable before the price dropped to 18 and 20 cents per pound, was probably kept at a loss. Young chickens should be hatched early. The cockerels will then bring more money and the pullets will be better matured and far more apt to lay in the fall and early winter. The prices on old hens are less in the late fall and early winter than in the late summer. Moreover the hens weigh less late in the season. It is a true statement that too many farmers know how to produce food supplies but do not know how to find a market, or put them on in an attractive manner.

Q. 43.—Do you think pure bred fowls pay the best?

Yes	449
No	91
Do not know	93
Believe in mixed breeds	3

Q. 44.—What type of fowl do you believe is the best for the farm use?

General purpose	265
Egg purpose	87
Meat purpose	8

This question was misunderstood, and a great many answers gave the varieties of chickens.

Q. 45.—Do you take a poultry paper?

Yes 202
No 475

What one? Twenty-six different kinds of poultry papers were used with no particular one predominating.

Q. 47.—Do you read the poultry page of any farm paper?

Yes 454
No 53

Q. 48.—Name some of the poultry problems and difficulties that confront you from day to day.

How to kill lice and mites 105
How to get eggs in winter 81
How to fight gapes 42
How to prevent roup..... 48
How to recognize disease and prevent it.. 17
Best ration for laying hens..... 11

Thirty-two other problems each with a few interested people were mentioned.

Most of these answers need a little explanation. The average farmer is interested in his poultry, and is studying it as much as his time will permit. He is a believer in pure bred fowls that are of a general purpose type. Space will not permit the handling of the disease question other than those mentioned, but it is easy to see that the common trouble with poultry is along the line of diseases. The Maine Experiment Station at Orono, Maine, has published a bulletin on "Diseases of Poultry," which may be obtained from it for 25 cents. This develops and shows pretty much in detail the best information to date on the subject of diseases.

In Indiana, the farm is the place on which to raise chickens; the conditions are natural and there is much waste feed available, thus making the product cheap. The best type of farming on the average, is what may be called diversified farming, thus having more than one source of income in case of the failure of some particular crop. On many farms the hen is the means of supplying the household with food and clothing besides things of lesser importance, too numerous to mention. In total production, Indiana stands well up in the list of states, but in her methods of marketing and the quality of her product, she is almost the worst in the corn-belt states. The reason for this has been given by the farmers themselves, simply neglect.

The hen is indespensable and even those who dislike her personally, generally appreciate the income that she can and does bring. Since it is impossible to do without her, her care should be the best, in order that she may bring forth a maximum production. A little study and a few simple changes and improvements such as suggested in this circular will greatly increase your pleasure and profit from your poultry.



Fig. 19. The practical side of poultry instruction. Teaching students to build poultry houses



Fig. 20. Students judging poultry. The best way to teach practical poultry husbandry

PURDUE UNIVERSITY
Agricultural Experiment Station

Circular No. 41

LaFayette, Ind., September, 1913

LICENSES FOR CREAMERIES AND TESTERS

LAWS, RULES AND REGULATIONS

O. F. Hunziker, Chief
Department of Dairy Husbandry

PURPOSE

The purpose of this circular is to acquaint Indiana creameries, milk receiving stations, cheese factories, ice cream factories, milk condenseries and all persons and firms receiving and paying for milk or cream on the basis of the butter fat contained therein, and all agents and employees of such persons and factories, with the laws of Indiana, 1913, referring to the licensing of creameries and testers, and with the rules and regulations concerning the enforcement of these laws by the Purdue University Agricultural Experiment Station.

THE CREAMERY AND TESTER'S LICENSE LAW (ACTS OF 1913), SIXTY-EIGHTH CONGRESS OF THE STATE OF INDIANA

Chapter 340

AN ACT to regulate the weighing and sampling of milk and cream and to provide for the examination of the glassware used for testing milk and cream for butter fat with the Babcock test; to prohibit the use of inaccurate testing glassware, weights and measures and glassware not conforming with the specifications of standard Babcock glassware; to define the term standard Babcock glassware, to prohibit the fraudulent manipulation of the Babcock test and the falsifying of the records thereof; to require the testing of milk and cream to be done or supervised by a licensed tester, to provide for the collection of license fees

from operators or supervisors of the Babcock test, and from creameries and other milk factories, and of fees for inspecting Babcock testing glassware from individuals and firms buying and paying for milk and cream on the butter fat basis; to fix penalties for the violation of the provisions of this act, and to authorize the expenditure of the funds received from the license fees and inspection fees and of additional funds provided for the execution of the provisions of this act.

[H. 572. Approved March 15, 1913]

Weights and Samples of Milk and Cream

Section 1. *Be it enacted by the general assembly of the State of Indiana,* That it shall be unlawful for any hauler of milk or cream or other person, or creamery, or other milk plant or agent, receiving milk or cream by weight or test or by weight and test, to fraudulently manipulate the weights of milk or cream of any patron or to take unfair samples thereof, or to fraudulently manipulate such samples. The hauler shall weigh the milk or cream of each patron accurately and correctly and shall report such weights accurately and correctly to the factory. He shall thoroughly mix the milk or cream of each patron by pouring and stirring until such milk or cream is uniform and homogeneous in richness, before the sample is taken from such milk or cream. When the weighing or sampling of the milk or cream of each patron is done at the creamery, shipping station or other factory, firm, corporation or individual buying and paying for milk or cream on the basis of the butter fat contained therein, the same rule shall apply.

Glassware for Testing Milk and Cream for Butter Fat

Section 2. Every person, firm, company, association, corporation or agent thereof, buying and paying for milk or cream on the basis of the amount of butter fat contained therein as determined by the Babcock test, shall use standard Babcock test bottles, pipettes and weights and accurate scales, as defined in section 13 of this act, and all Babcock test bottles, pipettes and weights shall have been inspected for accuracy by the Purdue University Agricultural Experiment Station, or its deputy, and shall be legibly and indelibly marked by the said Purdue University Agricultural Experiment Station, or its deputy, with the letters "S. G. P." (Standard Glassware Purdue). No bottle, pipette or weight shall be used for such test unless so examined and marked by the said Purdue University Agricultural Experiment Station. It shall be unlawful for any person, firm, company, association, corporation, or any of their agents to use any other than standard test bottles, pipettes and weights which have been examined and marked as provided in this section, to determine the amount of fat in milk or cream, bought and paid for on the butter fat basis.

Unlawful Tests

Section 3. It shall be unlawful for any person, firm or corporation, by himself or as the officer, servant, agent or employee of any person, firm or corporation, buying and paying for milk or cream on the basis of the amount of fat contained therein to underread, over-read or otherwise fraudulently manipulate the Babcock test used for determining the per cent. of fat in milk or cream, or to falsify the record thereof or to read the test at any temperature except the correct temperature which is 135 degrees to 140 degrees Fahrenheit, or to pay on the basis of any measurement or weight except the true measurement or weight which is seventeen and six-tenths (17.6) cubic centimeters for milk and nine (9) grams for cream. This section further provides that in all tests the cream shall be weighed into the test bottles.

License for the Tester

Section 4. Every creamery, shipping station or other factory, or person, or agent, receiving, buying and paying for milk or cream on the basis of the amount of butter fat contained therein shall have in its employ a licensed tester who shall supervise and be responsible for the operation of the Babcock test of milk and cream. The license shall be issued to such person by the Purdue University Agricultural Experiment Station upon presentation by the applicant of a certificate of proficiency properly filled out and signed by the chairman of the examining board and upon payment of a license fee as provided in section 7. This license shall be valid for the term of one year and shall be revoked by the said Purdue University Agricultural Experiment Station upon recommendation of the examining board if the licensee has failed to comply with the rules and regulations under which the license was granted: *Provided,* That the provisions of this section shall not apply to individuals, hotels, restaurants and boarding houses buying milk or cream for private use.

The Examining Board

Section 5. The examining board shall consist of three members, two to be appointed by the executive committee of the Indiana State Dairy Association, and the third member shall be the Chief of the Dairy Department of Purdue University Agricultural Experiment Station.

License for the Creamery

Section 6. Every creamery, shipping station, milk factory, cheese factory, ice cream factory, or milk condensery, or person, or agent, firm, company, association, or corporation, receiving, buying and paying for milk or cream on the basis of the butter fat contained therein, shall be required to hold a license. The license shall be issued to such creamery, shipping station, milk factory, condensery,

ice cream factory, cheese factory, or person, or agent, firm, company, association or corporation by the Purdue University Agricultural Experiment Station, upon complying with the provisions of sections 1 to 4 inclusive of this act, and upon payment of a license fee as provided in section 7. This license shall be valid for the term of one year, but shall be revoked by the said Purdue University Agricultural Experiment Station if the licensee fails to comply with the rules under which the license was granted: *Provided, however,* That the provisions of this section shall not apply to individuals, hotels, restaurants and boarding houses buying milk or cream for private use.

Fees for Licenses and for Inspection of Testing Glassware

Section 7. The tester's license shall be issued upon compliance with the provisions under section 4 of this act and upon payment by the candidate to the Purdue University Agricultural Experiment Station of the sum of two ($2.00) dollars. The creamery license shall be issued upon compliance with the provisions under section 6 of this act, and upon payment by the candidate, or his agent, to the said Purdue University Agricultural Experiment Station of the sum of six ($6.00) dollars. For all testing glassware inspected by the said Purdue University Agricultural Experiment Station, or its deputy, a fee of three (3) cents shall be paid by the owner of said testing glassware to the said Purdue University Agricultural Experiment Station for every piece of glassware so examined.

Accounting and Use of Funds

Section 8. The money for license fees and for inspection fees as provided for in section 7 shall be paid to the Director of the Purdue University Agricultural Experiment Station by whom it shall be paid to the Treasurer of Purdue University, the board of control of which shall expend the same, on proper vouchers to be filed with the Auditor of the State, in meeting all necessary expenses in carrying out the provisions of this act, including the employment of inspectors, chemist, expenses of issuing publications giving the results of glassware and factory inspection, as provided for in this act, and for any other expenses of said Purdue University Agricultural Experiment Station as authorized by law. The Director of the said Experiment Station shall include in his annual report to the Governor a classified report showing the total receipts and expenditures of all fees received under the provisions of this act.

Prosecuting Attorney—Duties

Section 9. It shall be the duty of every prosecuting attorney to whom the Purdue University Agricultural Experiment Station shall report any violation of the provisions of this act to cause proceedings to be commenced against the person or persons so violating

the provisions of this act, and to prosecute the same to final termination, according to the laws of the State of Indiana.

Penalties

Section 10. Any employee of a firm, company, association, corporation or person, buying and paying for milk or cream on the basis of the amount of butter fat it contains, violating any of the provisions of this act, shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be fined not less than twenty-five ($25.00) dollars, nor more than five hundred ($500.00) dollars, or be imprisoned in the county jail for not less than sixty (60) days nor more than twelve (12) months, or both. Any firm, company, association, corporation or person, buying or paying for milk or cream on the basis of the amount of butter fat contained therein, violating any of the provisions of this act, shall be guilty of misdemeanor, and upon conviction thereof shall be fined in the sum of one hundred ($100.00) dollars for the first offense and in the sum of not less than one hundred ($100.00) dollars, nor more than one thousand ($1,000.00) dollars for each subsequent offense.

Additional Funds

Section 11. That in order to insure sufficient funds to execute the provisions in sections 1 to 10, inclusive of this act, and to protect the milk and cream producers of the State against fraud and deception in the weighing, sampling and testing of milk and cream for butter fat, the following sums of money are hereby annually appropriated to Purdue University for the exclusive use of the Purdue University Agricultural Experiment Station. For the fiscal year ending September 30, 1913, one thousand ($1,000.00) dollars, and one thousand ($1,000.00) dollars annually thereafter, said sums to be paid quarterly to the Treasurer of Purdue University, out of any moneys of the treasury of the State of Indiana belonging to the general fund and not otherwise appropriated; the same to be expended for the purpose of providing the necessary equipment and paying the expenses of conducting the inspection of creameries, the examination of testing glassware, the examination of candidates for licenses and of disseminating information and instruction by means of publications and otherwise, as herein provided for.

Provisions

Section 12. The provisions of this act shall not take effect until April 1, 1914, except the provisions of section 11, which section, with its provisions, shall be in full force and effect on and after the passage of this act.

Standard Babcock Testing Glassware Defined

Section 13. The term "Standard Babcock Testing Glassware" shall apply to glassware and weights complying with the following specifications:

(a) Standard Milk Test Bottles

Graduation.—The total per cent. graduation shall be 8. The graduated portion of the neck shall have a length of not less than 63.5 millimeters (2½ inches). The graduation shall represent whole per cent., five-tenths per cent. and tenths per cent. The tenths per cent. graduations shall not be less than 3 millimeters in length; the five-tenths per cent. graduations shall be 1 millimeter longer than the tenths per cent. graduations, projecting 1 millimeter to the left; the whole per cent. graduations shall extend at least one-half way around the neck to the right and projecting 2 millimeters to the left of the tenths per cent. graduations. Each per cent. graduation shall be numbered, the number being placed on the left of the scale. The error at any point of the scale shall not exceed one-tenth per cent.

Neck.—The neck shall be cylindrical and the cylindrical shape shall extend for at least 9 millimeters below the lowest and above the highest graduation mark. The top of the neck shall be flared to a diameter of not less than 10 millimeters.

Bulb.—The capacity of the bulb up to the junction of the neck shall not be less than 45 cubic centimeters. The shape of the bulb may be either cylindrical or conical with the smallest diameter at the bottom. If cylindrical, the outside diameter shall be between 34 and 36 millimeters; if conical, the outside diameter of the base shall be between 31 and 33 millimeters, and the maximum diameter between 35 and 37 millimeters.

The charge of the bottle shall be 18 grams.

The total height of the bottle shall be between 150 and 165 millimeters (5⅞ and 6½ inches).

(b) Standard Cream Test Bottles

Two types of bottles shall be accepted as standard cream test bottles, a 50 per cent. 9 gram short-neck bottle and a 50 per cent. 9 gram long-neck bottle.

Fifty per cent. 9 gram short-neck bottles. Graduation.—The total per cent. graduation shall be 50. The graduated portion of the neck shall have a length of not less than 63.5 millimeters (2½ inches). The graduation shall represent five per cent., one per cent. and five-tenths per cent. The five per cent. graduations shall extend at least half-way around the neck (to the right). The five-tenths per cent. graduations shall be at least 3 millimeters in length, and the one per cent. graduations shall have a length intermediate between the five per cent. and the five-tenths per cent. graduations. Each five per cent. graduation shall be numbered, the number being

placed on the left of the scale. The error at any point of the scale shall not exceed five-tenths per cent.

Neck.—The neck shall be cylindrical and the cylindrical shape shall extend at least 9 millimeters below the lowest and 9 millimeters above the highest graduation mark. The top of the neck shall be flared to a diameter of not less than 10 millimeters.

Bulb.—The capacity of the bulb up to the junction of the neck shall not be less than 45 cubic centimeters. The shape of the bulb may be either cylindrical or conical with the smallest diameter at the bottom. If cylindrical, the outside diameter shall be between 34 and 36 millimeters; if conical, the outside diameter of the base shall be between 31 and 33 millimeters and the maximum diameter between 35 and 37 millimeters.

The charge of the bottle shall be 9 grams. All bottles shall bear on top of the neck above the graduations, in plainly legible characters, a mark defining the weight of the charge to be used (9 grams).

The total height of the bottle shall be between 150 and 165 millimeters (5⅞ and 6½ inches), same as standard milk test bottles.

Fifty per cent. 9 gram long-neck bottles.—The same specifications in every detail as specified for the 50 per cent. 9 gram short-neck bottle shall apply for the long-neck bottle with the exception, however, that the total height of this bottle shall be between 210 and 235 millimeters (8¼ and 8⅞ inches) and that the total length of the graduation shall be not less than 120 millimeters.

The Standard Babcock Pipette

Total length of pipette not more than 330 millimeters (13¼ inches). Outside diameter of suction tube 6 to 8 millimeters. Length of suction tube 130 millimeters. Outside diameter of delivery tube 4.5 to 5.5 millimeters. Length of delivery tube 100 to 120 millimeters. Distance of graduation mark above bulb 30 to 60 millimeters. Nozzle straight. Delivery 17.6 cubic centimeters of water at 20 degrees C. in five to eight seconds.

Standard Weights

The standard weight shall be nine (9) grams.

RULES AND REGULATIONS

Licenses for Creameries

Creamery licenses will be issued to creameries, shipping stations, cheese factories, ice cream factories, milk condensing factories, market milk plants, etc., complying with sections 1, 2, 3, 4, 6, 7 and 13 of the laws herein stated and with the following rules and regulations:

Rule 1.—Creamery Report Blank and License Fee.—On or before April 1 of each year a creamery report and application blank

must be properly filled out, duly sworn to and sent, together with remittance of the license fee of six ($6.00) dollars, to the Chief of the Department of Dairy Husbandry, Purdue University, Lafayette, Indiana. (See "Supplement to Circular No. 41")

Upon receipt of the license the same must be posted in plain sight in the testing room of the factory. Creamery licenses are valid for one year and must be renewed on or before April 1, of each year.

Rule 2.—Examination of Standard Babcock Testing Glassware.—Send all testing glassware properly packed to the following address: O. F. Hunziker, Chief, Department of Dairy Husbandry, Purdue University Agricultural Experiment Station, Lafayette, Indiana.

Glassware may be sent by parcel post, express or freight. All transportation charges must be prepaid by the sender.

All shipments of glassware must be accompanied by a check, draft or money order, covering charges of examination of such glassware on the basis of three (3) cents for each piece of glassware.

Shipments of glassware arriving collect, or without remittance for examination, will be held until payment for transportation and examination fees are made. Postage stamps will not be accepted as payment for such charges.

Testing glassware sent direct from the manufacturer or dealer of glassware is subject to the same rule.

When ordering Babcock testing glassware from the manufacturer or dealer specify that standard glassware, in accordance with the requirements of the Indiana law, as described in this circular, is wanted. Glassware not conforming with the specifications of standard glassware will be rejected and returned at the owner's expense.

When shipping glassware for examination, state clearly how it should be returned, whether by express or freight. In the absence of such instructions, glassware after examination will be returned by freight.

After examination of the glassware every piece found correct will be marked with the letters "S. G. P." (Standard Glassware Purdue) and promptly returned to the owner. A detailed report of the total pieces of glassware received and found correct will be mailed to the owner. The use of glassware not bearing the letters S. G. P. is in violation of the laws of Indiana under which creamery licenses are granted.

Rule 3.—Sampling and Testing of Milk and Cream.—The sampling and testing of milk and cream must be performed in accordance with the directions for "Testing Milk and Cream" as stated on pages 9 to 15, inclusive, of this circular and in Circular No. 42.

Licenses for Testers

Testers' licenses will be issued to every person complying with sections 2, 3, 4 and 7 of the laws herein stated and with the following rules and regulations:

Rule 4.—Date and Place of Examination.—The candidate for a tester's license must take and successfully pass the tester's license examination at Purdue University, Lafayette, Indiana, and at the date hereafter designated and announced by the chairman of the Examining Board. The announcements of such examinations will be issued in special circulars, and in the dairy and state press not less than one month in advance of the date set for such examination.

Rule 5.—License Fees.—The candidate for the tester's license, who has successfully passed the examination must pay to O. F. Hunziker, Chief, Department of Dairy Husbandry, Purdue University Agricultural Experiment Station, the sum of two ($2.00) dollars on or before April 1, of each year. Testers' licenses are valid for one year and may be renewed annually without examination, provided that the applicant has carried out the provisions under which the license was granted, and upon payment of the annual license fee, on or before April 1, of each year.

The tester's license must be posted in plain sight in the testing room of the factory in which the tester is employed. The license will be revoked, if the licensee has failed to comply with the rules and regulations under which it is granted.

Examinations of Applicants for Testers' Licenses

The examination will consist of a laboratory exercise and a written test.

The Laboratory Exercise will cover a three hour period in which the applicant will test various samples of milk and cream with the Babcock test.

In the Written Test the applicant will be required to answer a series of questions on the composition, sampling and testing of milk and cream.

QUESTIONS AND ANSWERS WHICH THE SUCCESSFUL APPLICANT FOR THE TESTER'S LICENSE SHOULD KNOW

Question 1.—What is the composition of average, normal milk?

Answer.—Water		87.0 per cent.
Fat		4.0 per cent.
Casein		3.0 per cent.
Albumen		.5 per cent.
Milk sugar		4.8 per cent.
Ash		.7 per cent.
Total		100.0 per cent.

Question 2.—How should the milk sample be preserved?

Answer.—Use a clean bottle with a tight seal, such as bottles with patent tin caps, or screw tops, or cork or glass stoppers. Add one large corrosive sublimate tablet, or other preservative. Dissolve the tablet by shaking. Seal tightly and place in a cool place. If additional samples are taken into the same jar, mix after each addition by giving the bottle a rotary motion.

Question 3.—How should the milk sample be prepared for the test?

Answer.—Mix the contents thoroughly until all the fat is uniformly mixed into the milk. This is best done by shaking or by pouring from one jar to another several times.

Question 4.—When the milk sample contains lumps of dried cream or butter, how should it be treated before testing?

Answer.—Melt the fat by setting the jar into warm water until all lumps have disappeared, then shake thoroughly and pipette into test bottle at once.

Question 5.—When the milk sample is sour and contains lumps of curd, how should it be treated before testing?

Answer.—Add a knife point full of soda lye, shake and let stand until the curd is completely dissolved.

Question 6.—How much milk and how much acid should be used?

Answer.—17.6 cubic centimeters of milk;
17.5 cubic centimeters of acid.

Question 7.—What kind and what strength acid should be used?

Answer.—Commercial sulphuric acid, specific gravity 1.82 to 1.83.

Question 8.—What should be done if the acid is too weak?

Answer.—When slightly too weak, use a trifle more acid. When much too weak, return the acid to store.

Question 9.—What should be done, if the acid is too strong?

Answer.—When slightly too strong use a trifle less acid. When much too strong dilute the acid with a small amount of water. Pour the acid into the water. Do not pour water into the acid; it is dangerous.

Question 10.—At what temperature should milk and acid be before mixing?

Answer.—55 degrees to 70 degrees F.

Question 11.—How many minutes should the bottles be whirled in the tester?

Answer.—First whirling, five minutes; second whirling, two minutes; third whirling, one minute.

Question 12.—What is the correct speed of the tester?

Answer.—12 inch tester, 1000 revolutions per minute;
18 inch tester, 800 revolutions per minute.

Question 13.—At what temperature should the test be read?

Answer.—At 135 to 140 degrees F.

Question 14.—How should the temperature of the fat in the bottles be regulated?

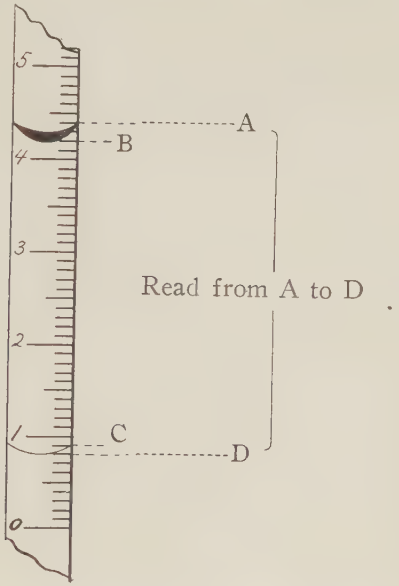
Answer.—Set the bottles in a water bath at 135 to 140 degrees F. for five minutes. The water must reach to the top of the fat column.

QUESTION 15.—What is the meniscus?

Answer.—The curve at the bottom and top of the fat column.

QUESTION 16.—How should the test be read? Draw diagram.

Answer—



QUESTION 17.—What do the subdivisions in the 8 per cent. test bottles represent?

Answer.—Each subdivision is one-tenth per cent.

QUESTION 18.—How should the cream sample be taken?

Answer.—Mix the cream in the can or pail thoroughly by pouring or stirring until it is homogeneous in body and all lumps have disappeared.

QUESTION 19.—How should composite samples of cream be taken?

Answer.—Composite samples of cream are unlawful and should not be taken at all.

QUESTION 20.—How soon after taking, should cream samples be tested?

Answer.—As soon as possible.

QUESTION 21.—How should the cream sample be prepared for the test?

Answer.—It should be mixed by pouring or stirring until the cream is uniform in body and all lumps have disappeared.

QUESTION 22.—How should lumpy cream samples be prepared for the test?

Answer.—Heat to 110 degrees F. in water, shake and weigh out at once.

QUESTION 23.—Why should cream be weighed into the test bottle instead of measured?

Answer.—Because measuring does not give an accurate test. The specific gravity of cream varies with its fat content and other conditions and it is difficult to transfer all the cream in the pipette to the test bottle.

QUESTION 24.—What is the correct weight for testing cream?

Answer.—9 grams.

QUESTION 25.—What precautions should be observed in the weighing of the cream?

Answer.—Use a sensitive balance, properly balanced, in good working order and protected against drafts while weighing. If any cream is spilled on the balance, remove it before the weighing is completed.

QUESTION 26.—How much sulphuric acid should be used?

Answer.—Use enough acid so that the mixture of acid and cream immediately after shaking has a coffee-brown color. Usually eight to twelve cubic centimeters of acid are required.

QUESTION 27.—At what temperature should the cream tests be read?

Answer.—At 135 to 140 degrees F.

QUESTION 28.—How is the temperature best regulated?

Answer.—By setting the cream test bottles into a water bath at 135 degrees to 140 degrees F. for ten minutes.

QUESTION 29.—What is glymol?

Answer.—Glymol is a high quality of white mineral oil. It may be secured from the druggist.

QUESTION 30.—Why is glymol used in the cream test?

Answer.—In order to remove the meniscus on top of the fat column and secure a straight and sharply defined line for reading.

QUESTION 31.—How much glymol should be used and when should the glymol be added?

Answer.—Use a few drops of glymol and add it immediately before reading.

QUESTION 32.—How is glymol best added?

Answer.—Use a glass tube, pipette or burette and allow the glymol to run down the side of the neck. If poured direct on the fat column it tends to mix with the fat, causing the surface of the fat column to be ragged and indistinct.

QUESTION 33.—Should glymol be used in the milk test?

Answer.—No. It is necessary to include the meniscus in the reading of the milk test in order to compensate for the loss of residual fat in the bulb of the bottle. If glymol were used, the reading of the milk test would be too low.

QUESTION 34.—How should the cream test be read in the case glymol is not available?

Answer.—Include in the reading one-third of the meniscus.

QUESTION 35.—What causes bubbles of air on top of the fat column and how can their presence be avoided?

Answer.—Air bubbles are due to the use of hard water. If the available tap water is hard, soften it by boiling or by the addition to it of a few drops of sulphuric acid, or use rain water or distilled water.

QUESTION 36.—What causes a milky and curdy fat column?

Answer.—Too little or too weak acid.

QUESTION 37.—What causes a dark and charred fat column?

Answer.—Too much or too strong acid.

QUESTION 38.—How much cream should be taken for the sample and why?

Answer.—Not less than one ounce, in order to have enough cream left for a re-test.

QUESTION 39.—Under what conditions should a re-test be made?

Answer.—Whenever the test varies 3 per cent. or more from the test of the previous shipment of the same patron, a re-test should be made.

QUESTION 40.—What are standard milk test bottles?

Answer.—Standard milk test bottles are test bottles graduated to 8 per cent. with subdivisions of one-tenth per cent.

QUESTION 41.—What are standard cream test bottles?

Answer.—There are two types of standard cream test bottles, the 50 per cent. 9 gram 6 inch and the 50 per cent. 9 gram 9 inch. The subdivisions of both types represent five-tenths per cent.

QUESTION 42.—What do the letters S. G. P. mean, which are etched on the bulb of the bottles?

Answer.—The letters S. G. P. stand for the words "Standard Glassware Purdue." They mean that the bottles bearing these letters have been examined by the Purdue University Agricultural Experiment Station and were found correct. The use of bottles not so marked is prohibited by law.

QUESTION 43.—How long is the tester's license valid, when should it be renewed and what are the requirements for renewing the license?

Answer.—The tester's license is valid for one year. It must be renewed on or before April 1 of each year. It can be renewed by making application for same to the Chief of the Department of Dairy Husbandry, Purdue University Agricultural Experiment Station, and by paying the license fee of $2.00. This should be done on or before April 1, of each year.

QUESTION 44.—What should be done with the tester's license?

Answer.—The tester's license must be posted in the testing room of the factory in plain sight.

QUESTION 45.—Under what conditions is the tester's license revoked?

Answer.—The tester's license is revoked whenever the licensee fails to comply with the provisions of the law and the rules and regulations of the Purdue University Agricultural Experiment Station and upon non-payment of the annual license fee.

QUESTION 46.—What is the purpose of the law requiring creameries and other milk factories to have in their employ licensed testers?

Answer.—The purpose of this law is to insure accurate, honest and reliable tests of milk and cream, for the protection of the milk producer and the manufacturer alike.

QUESTION 47.—Name four important requirements for accurate testing of milk and cream.

Answer.—Fair and representative samples, correct weighing, accurate glassware and correct reading of the test.

QUESTION 48.—How can you tell whether you are using accurate glassware?

Answer.—The letters S. G. P., etched on the bulb of the test bottles, are the guarantee for accurate glassware.

QUESTION 49.—How can you tell whether the cream test balance sets level and is in good working condition?

Answer.—The cream balance sets level when the vertical dial lines up exactly with the center of the vertical standard. It is in good working condition when the arms of the balance swing freely and without sticking.

QUESTION 50.—What would you do when in doubt about the correctness of any part of your work?

Answer.—Consult Purdue University Agricultural Experiment Station Circulars Nos. 41 and 42, and if not satisfied with the information found therein, write to the Department of Dairy Husbandry, Purdue University Agricultural Experiment Station, for advice.

PURPOSE OF QUESTIONS AND ANSWERS

The purpose of submitting the above questions and answers is to outline to the prospective candidate for a tester's license the scope of the subject which he should know and on which he may be examined. It is to put before him in as clear, definite and brief a form the information he desires and needs to assist him in his preparation and to help him to successfully pass the examination.

It should not be understood from the above that the examination will contain these questions word for word, nor that it will be confined to these questions only, nor that it will cover all these questions. They merely serve as a guide for the benefit of applicants for testers' licenses.

DIRECTIONS FOR MANUFACTURERS OF AND DEALERS IN BABCOCK TESTING GLASSWARE

All Babcock testing glassware sold to persons and firms located in the State of Indiana must conform with the specifications for standard glassware as stated on pages 2 and 6 to 7, inclusive, of this circular. Babcock testing glassware not conforming with these specifications will be rejected and returned at the vendor's expense.

Glassware sent to the Purdue University Agricultural Experiment Station to be tested and forwarded to the purchaser must be accompanied by a tag bearing the name and full address of the purchaser. Such glassware must be shipped prepaid. Shipments arriving collect will be held until remittance arrives for transportation.

Ship all glassware to the following address:—O. F. Hunziker, Chief, Department of Dairy Husbandry, Creamery License Division, Purdue University Agricultural Experiment Station, Lafayette, Ind.

WHERE DETAILED ADDITIONAL INFORMATION ON THE TESTING OF MILK AND CREAM MAY BE FOUND

Indiana creameries and other milk factories and their employees and other persons desiring to secure detailed information and instructions regarding the testing of milk and cream for butter fat are referred to Purdue University Agricultural Experiment Station Circular No. 42. Address Dairy Department, Purdue University Agricultural Experiment Station, Lafayette, Indiana. This circular deals exclusively with the testing of milk and cream and is issued expressly for the purpose of assisting applicants for testers' licenses.

THE EXAMINING BOARD

The members of the Examining Board were appointed by the Executive Committee of the Indiana State Dairy Association, October 14, 1913, in accordance with the Creamery License Law, Acts of 1913, Chapter 340, Section 5.

The Examining Board organized and held its first meeting October 21, 1913. The following are the members of the Board:—O. F. Hunziker, Chairman, Samuel Schlosser and D. B. Johnson.

INDEX

		Pages
I.	Creamery and Tester's License Law	1–7
	Additional Funds, Section 11	5
	Accounting and Use of Funds, Section 8	4
	Examining Board, Section 5	3
	Fees for Licenses and for Inspection of Testing Glassware, Section 7	4
	Glassware for Testing Milk and Cream, Section 2	2
	License for the Creamery, Section 6	3–4
	License for the Tester, Section 4	3
	Penalties, Section 10	5
	Prosecuting Attorney—Duties, Section 9	4–5
	Provisions, Section 12	5
	Standard Babcock Testing Glassware, Section 13	6–7
	Unlawful Tests	3
	Weights and Samples of Milk and Cream	2
II.	Rules and Regulations	7–15
	[1]Creamery and Milk Plant Report Blank	
	Directions for Manufacturers of and Dealers in Babcock Testing Glassware	15
	Examinations for Licensed Testers, Date and Place of Examining Board	9
	Information on Testing, Where It may be Obtained	15
	Examination of Standard Babcock Glassware	8
	License Fees for Creameries	7
	License Fees for Testers	9
	Licenses for Creameries	7
	Licenses for Testers	8–9
	Purpose of Circular	1
	Purpose of Questions and Answers, which Successful Applicants for Tester's License Should Know	15
	Questions and Answers, which the Successful Applicant for the Tester's License Should Know	9–15
	Sampling and Testing of Milk and Cream	8
	The Examining Board	15

[1] See detached "Supplement to Circular No. 41"

PURDUE UNIVERSITY
Agricultural Experiment Station

Circular No. 42

LaFayette, Ind., January, 1914

TESTING MILK AND CREAM FOR BUTTER FAT

O. F. Hunziker, Chief
Department of Dairy Husbandry

PURPOSE

The purpose of this circular is to furnish to the milk and cream producers and the manufacturers of dairy products of the State accurate, concise and understandable directions for testing milk and cream in accordance with the most approved and practical methods of using the Babcock test.

These directions are especially intended also for the information of applicants for testers' licenses, and supplementary to the instruction offered in Purdue University Agricultural Experiment Station Circular No. 41.

MILK TESTING

Sampling the Milk

The sampling is the most important operation of the test. Unless the sample is representative of the milk from which it is taken the result of the test can not be correct. The fundamental cause of non-representative samples lies in the fact that the butter fat is lighter than the remainder of the milk constituents. When the milk is allowed to lie in the cans undisturbed, the butter fat rises to the surface. Unless the milk is thoroughly mixed before sampling, a representative sample cannot be taken.

Single Samples of Milk.—The most accurate and reliable method of sampling is to take single samples of each patron and test them daily. In order to minimize the work, the sample may be

pipetted from the properly mixed milk in the weigh can direct into the Babcock test bottle. In this way the extra work of handling sample jars and of preparing the milk in the jar for the test is made unnecessary and all danger of fat separation before the sample reaches the test bottle is avoided.

Another practice of taking single samples is to take and test samples from every other or every third delivery of milk. At the end of the month or other period of payment, these individual tests are averaged and the pounds of butter fat are calculated by multiplying the average test by the total pounds of milk received for that period. This practice is obviously less reliable than where single samples are taken and tested daily. However, experimental results indicate that samples taken as often as every third day give results which compare very closely with those obtained from daily samples.



Fig. 1. The glass-stoppered milk sample bottle furnishes an ideal seal



Fig. 2. The milk sample bottle with the metal cap is very satisfactory

Composite Samples of Milk.—The purpose of taking composite samples is to reduce the labor and expense of testing. The true composite sample consists of aliquot portions of milk of several deliveries from the same patron.

Jars for Composite Sampling.—Composite sample jars must have a tight seal in order to prevent evaporation of moisture. Pint jars sealed with glass stoppers, cork stoppers, metal caps or screw tops may be used for this purpose. Bottles with paper caps and jelly glasses with tin lids do not furnish tight seals; they should not be used for this purpose.

A separate jar is used for each patron and each jar must bear the respective patron's number. The jars should be thoroughly clean and, in order to guard against errors, they should be arranged on convenient shelves near the weigh can in numerical order, grouping the jars of patrons of the same route together.

Taking Composite Samples.—Correct composite samples may be obtained by the use of a milk thief or a graduated pipette. If the milk thief is used, it is inserted into the weigh can of the entire delivery of one patron. The milk in the tube rises to the level of the milk in the weigh can. The milk thief is then emptied into the sample jar. In case the graduated pipette is used, a certain quantity of milk is taken for every pound of milk delivered by the patron (usually about .1 cubic centimeter for every pound of milk delivered). The milk thief is the handier instrument of the two, but where the amount of milk delivered by different patrons varies considerably, the samples of milk from the larger milk producers are often too large to be practical.

Other so-called composite samples are taken by using the same measure for all milk receipts. In this case a small dipper holding about one ounce is generally used. With this dipper a sample of milk is taken daily from the weigh can of each patron's milk and transferred into the sample jar. This method of composite sampling is not mathematically correct and the results tend to be less reliable, although experimental data show that the results average practically the same as where aliquot portions are taken.

Objection to Composites.—The chief objection to composite samples of milk is that the composite samples are usually held too long before testing. This causes a more or less complete separation of the butter fat in the form of a thick and tough layer of cream. This cream mixes with difficulty back into the remainder of the sample so that the portion transferred to the test bottle is often not representative of the true richness of the milk. This defect is especially pronounced where the samples are not protected against high temperature (summer heat).

Composite samples of milk should be held for not longer than one week and tested at the end of that period.

Care of the Milk Sample

The milk sample should be in as normal condition as possible at the time of testing, otherwise it will be difficult to pipette a representative portion into the test bottle. This difficulty is entirely avoided where the sample is transferred with the 17.6 cubic centimeter pipette from the weigh can direct to the test bottle. The changes which the improperly kept sample undergoes are caused by evaporation and by fermentation.

Evaporation causes the per cent. of fat and other solids to increase, yielding misleading tests. It also tends to dry the milk on the surface, causing the formation of a tough, leathery layer. In this condition it is difficult to secure a representative portion for the

test. This can be prevented by giving the sample jar a gentle rotary motion after each addition of milk, by properly replacing the cap or stopper after each addition of the milk, by protecting the sample from excessive heat and by testing at least once per week.

Fermentation causes the milk to spoil, and the milk usually becomes curdy and mouldy. In this condition it can not be properly pipetted into the test bottle unless specially treated. Fermentation can be prevented by starting the composite sample with a clean bottle, preventing the slobbering of the milk over the outside of the bottle and by adding a small amount of a preservative, such as corrosive sublimate, potassium by-chromate or formaldehyde.

Corrosive sublimate tablets are the most convenient and least objectionable form of preservative. Use one tablet in each bottle. Put it into the sample at the time the first portion of the composite sample is taken. Shake the bottle by giving it a rotary motion until the tablet is dissolved. After each addition of milk to the bottle, shake again, giving the bottle a rotary motion until the contents are thoroughly mixed. This precaution has the further advantage of preventing the formation of a tough layer of cream and facilitates the preparation of the sample for the test. One preservative tablet preserves one pint of milk for about two weeks. When purchasing preservative tablets from creamery supply houses ask for large sized corrosive sublimate tablets. It is advisable to crush the tablet before dissolving, in order to avoid the need of excessive agitation which tends to churn a portion of the fat.

Preparation of Sample for the Test

Before testing, the samples should be brought to the proper temperature; this may range from 55 degrees to 70 degrees F. If the samples have been exposed to summer heat or to temperatures near the freezing point, the sample bottles are best set into a tank, sink or tub and allowed to stand in water at about 60 degrees F. until the temperature of the milk is neither below 55 degrees F. nor above 70 degrees F.

The contents of each bottle must be thoroughly mixed before pipetting into the test bottle. If the composite sample has received the proper care, as directed on page 3, the gentle shaking of the sample bottle and the pouring of the contents from one bottle to another several times should be sufficient.

Samples containing lumps of cream or granules of butter can not be tested properly without extra preparation. They should be heated to at least 110 degrees F., or until all lumps of butter fat have melted and disappeared; they should then be shaken vigorously and pipetted into the test bottle at once. Even with this precaution it is difficult to transfer to the test bottle a representative portion from such a sample.

Sour and curdy samples should be treated as follows: add one half teaspoonful of soda lye or potash lye, shake and let stand until all lumps of curd have disappeared. The sample is then ready for the test. When testing samples to which soda lye or other alkali has been added, the acid should be added slowly and carefully to avoid accidents and to prevent the loss of a portion of the contents of the bottle by excessive effervescence.

Milk Test Bottles

The standard milk test bottle is the 8 per cent. bottle. This bottle is graduated to .1 per cent. The main divisions represent 1 per cent. The figures are located at the left of the graduation. For detailed specifications for "Standard Milk Test Bottles" see Agricultural Experiment Station Circular No. 41.

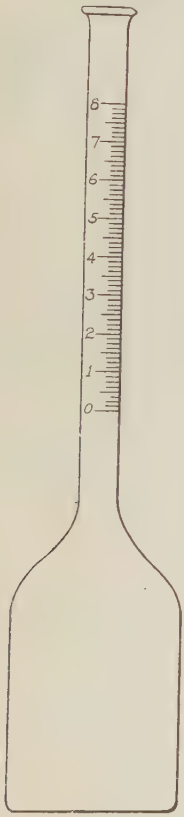


Fig. 3. The Standard milk test bottle is graduated to 8 per cent. with subdivisions of .1 per cent.

Measuring the Milk Into the Test Bottle

Use a standard 17.6 cubic centimeter pipette and a standard 8 per cent. milk test bottle. Draw the milk from the properly prepared sample into the pipette and fill the pipette to the 17.6 cubic centimeters mark. Discharge the pipette into the test bottle. In order to do this rapidly and to prevent spilling, drop the discharge end of the pipette into the neck of the test bottle until the bulb of the pipette rests on the neck of the bottle, then release the milk. Blow the last drop of milk out of the pipette before removing it from the bottle. Mark each bottle with a number corresponding with the name or number of the respective patron on the test sheet. The marking is best done with a lead pencil.



Fig. 4. The 17.6 c.c. Standard pipette for milk

Adding Acid

Use commercial sulphuric acid, specific gravity 1.82 to 1.83. The temperature of the acid should be the same as that of the milk, 55 degrees F. to 70 degrees F. In order to insure the proper temperature of the acid it is advisable to set the acid bottle into the tank containing the milk sample bottles.



Fig. 5. The 17.5 c.c. acid cylinder



Fig. 6. The combined acid bottle for rapid work

Add 17.5 cubic centimeters of acid to the milk in the test bottle and mix by giving the bottle a rotary motion until the lumps of curd are completely dissolved and the mixture presents a black color. It is advisable to add the acid in about three installments, shaking the bottle after each addition. Attention to this precaution helps to secure clear tests.

Whirling and Adding Water

Set the test bottles into the Babcock centrifuge. If the test bottles containing the mixture of milk and acid are held over and allowed to become cool, they should be heated by setting in hot water before whirling.

Steam turbine and electric driven testers with not less than twenty-four pockets are best adapted for factory use. They are constructed of two general sizes,—those having a twelve inch diameter wheel and those having an eighteen inch diameter wheel.

Whirl for five minutes at the proper speed. A tester with a twelve inch wheel requires one thousand revolutions and a tester with an eighteen inch wheel requires eight hundred revolutions per minute.

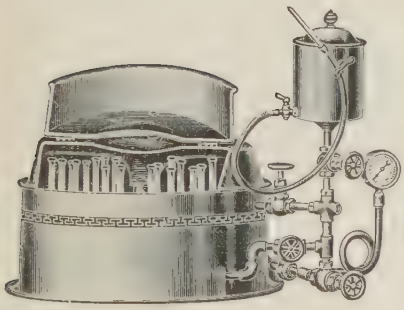


Fig. 7. The Babcock tester—"Facile"

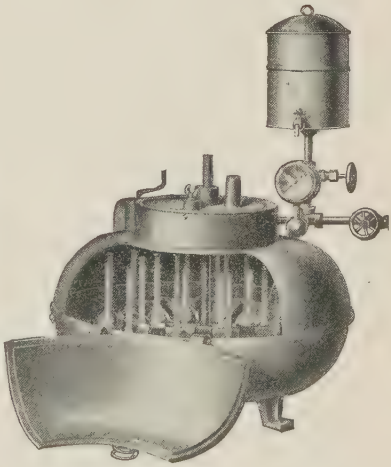


Fig. 8. The Babcock tester—"Wizard"

Fill the bottles to the bottom of the neck with hot, soft water; whirl again for two minutes and fill the bottles with hot, soft water to about the 7 per cent. mark; whirl for one minute. The temperature of the water added should be not lower than 140 degrees F. and preferably near that of boiling water (212 degrees F.).

Reading the Test

Place the test bottles in a water bath at 135 degrees to 140 degrees F. for five minutes. Measure the fat column with a pair of dividers, including the meniscus or curve, both, at the bottom and

at the top of the fat column. Each subdivision represents .1 per cent.; each main division represents 1 per cent. Record the per cent. of fat thus found on the test sheet.

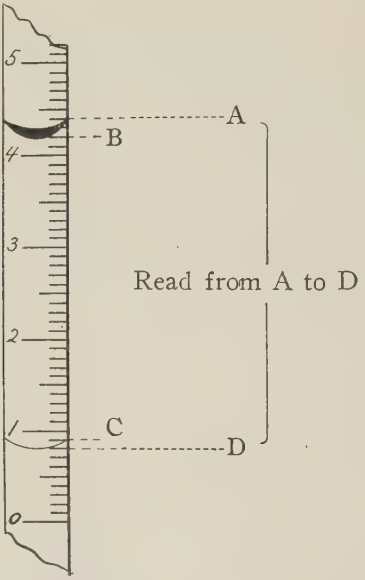


Fig. 9. Showing how the milk test should be read

Abnormal Appearance of the Fat Column

When the test is made properly and in accordance with above directions, the fat column is perfectly clear, has a golden yellow color and the top and bottom curves are sharply defined.

The presence of whitish curd in or immediately below the fat column is the result of excessively cold milk and acid, or the use of too little or too weak acid.

The presence of charred and dark curdy masses in the fat column is caused by too warm milk and acid, or too much or too strong acid.

Such tests should be rejected, as the readings of the same are prone to be inaccurate.

The appearance of foam on the surface of the fat column is caused by the use of hard water. The carbonates, when acted on by the sulphuric acid, break down, liberating carbon dioxide gas which, rising through the fat column, gathers on its surface in the form of air bubbles. Where soft water, distilled water, or rain water is not available, the water may be softened by boiling it or by the addition to it of a few drops of sulphuric acid before use.

CREAM TESTING

Sampling the Cream

One of the most common causes of incorrect cream tests lies in the inaccuracy of the cream sample. The difficulty of securing accurate cream samples is greatly augmented by the fact that the cream, at the time of sampling, is often in no condition to be sampled correctly.

Care of the Cream on the Farm.—In order to facilitate accurate sampling by the cream hauler, shipping station agent or creamery, the cream should receive the proper care on the farm. The separator should be thoroughly cleaned after each separation and the cream screw or skim milk screw so set as to discharge cream containing about 35 to 45 per cent. fat. After separation the cream should be cooled and kept cool. This is best done by setting the cans containing it into a trough or tank of cold water. The cream cans should remain in the cold water until they leave the farm. The cream should be stirred occasionally to prevent excessive separation of the fat and the drying of the cream on the surface.

Sampling by the Cream Hauler.—Where the cream is gathered at the farm by the cream hauler, the creamery should see to it that its haulers or agents have the necessary equipment and be given proper instructions for taking samples right. The equipment should consist of a spring scale, capacity not less than sixty pounds, for weighing the cream; a weighing pail in which each farmer's cream is weighed separately; a combined stirrer and sampler properly constructed; a rubber scraper for scraping the cream from the sides and bottom of the farmer's pail or can and from the weigh pail after each weighing; a set of properly numbered sample bottles with tight stoppers or screw tops and arranged in a rack in numerical order; cans, preferably ten-gallon cans, into which to empty the weigh pail; and a cream report book. The cream should be thoroughly stirred with the stirrer, until it is completely mixed, then poured into the weigh pail, weighed and sampled. The mixing may be made more thorough by pouring the cream from one pail to another several times. The scales should not be held up by hand, but should be suspended from a stationary hook, preferably attached to the rear of the wagon. After pouring the cream into the large can, the weigh pail should be thoroughly scraped with the rubber scraper, removing the remnants of cream that adhere to the sides and bottom of this pail. The sample bottles, after filling, should be sealed tightly and returned to their places in the rack. In case the weigh pail does not hold all the cream of one patron, a separate sample should be taken from each weighing and the corresponding weights recorded.

Where the cream of each patron is sampled at the creamery or shipping station, the same precautions should be observed. The mixing is best accomplished by pouring or stirring. In order to facilitate the pouring, to save time and to prevent unnecessary loss by spilling, a few straight-walled cans with the tops entirely open should be provided. These cans should be large enough to easily take care of the contents of a ten-gallon can without overflowing.



Fig. 10. The cream stirrer and sampler should have a stout rod with handle and a disc not less than three or four inches in diameter



Fig. 11. The cream scales

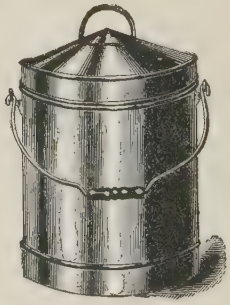


Fig. 12. The weigh pail

When the cans are not too full, thorough mixing is permissible by stirring, provided that a stirrer with a good sized disc and a stout rod, not less than thirty inches long and with a good hand hold be used. When the cream is mixed by stirring, the stirring must be done thoroughly; simply giving the cream a few dips with the sample dipper is not sufficient. The stirrer must be worked to the bottom of the can several times and the entire contents of the can must be thoroughly agitated. Thick cream should be warmed until it pours readily; frozen cream should be warmed until the icy portions have completely disappeared. Churned cream can not be sampled accurately. Its fat content may be calculated by testing the buttermilk and estimating the amount of butter.

Composite Samples of Cream.—Composite samples of cream are not permissible. They are exceedingly difficult to obtain and are prone to give misleading results.

Care of the Cream Sample

The cream samples are in the best condition for testing immediately after sampling or as soon as they arrive at the factory. Samples which are not tested upon arrival at the creamery or soon after, should be placed in the refrigerator until ready for the tester. The cream sample bottles or tubes should be sealed tightly; screw top seals or cork stoppers answer the purpose.

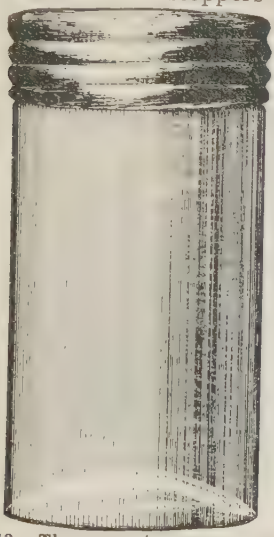


Fig. 13. The screw-top cream sample jar

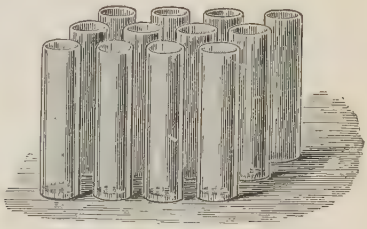


Fig. 14. Cream sample tubes



Fig. 15. Cork stopper with numbered metal tag

Preparation of the Cream Sample for the Test

Samples of fresh cream of normal richness, and which is not perceptibly separated can be tested accurately without special preparation, other than mixing thoroughly by shaking or pouring before use. Thick and semi-solid samples which are otherwise in good condition should be warmed to about 90 degrees F., then poured gently and weighed at once. Cream samples in which the butter fat is completely separated and churned, or has formed a compact, tough and leathery layer, as is the case with old samples not stored at a low temperature, should be heated high enough to melt the butter fat, 110 degrees F. or above, then shaken thoroughly and weighed out at once. It should be understood that samples in this condition are at best difficult to handle and tend strongly toward inaccurate results.

Weighing the Cream into the Test Bottle

The cream must be weighed into the test bottle, not measured. This is necessary in order to secure the correct amount by weight. Cream varies in weight with its richness and its mechanical condition, and no one measure will hold the correct amount of cream of varying richness. The correct amount of cream by weight is nine grams.

Cream Scales.—The cream scales must be accurate and sensitive to at least one-tenth gram; they should rest on a firm and level table, be properly adjusted and kept in good working order.

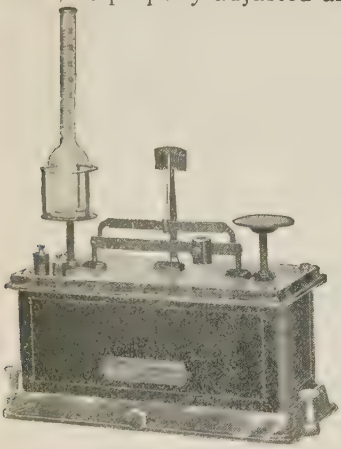


Fig. 16. A very sensitive cream test balance

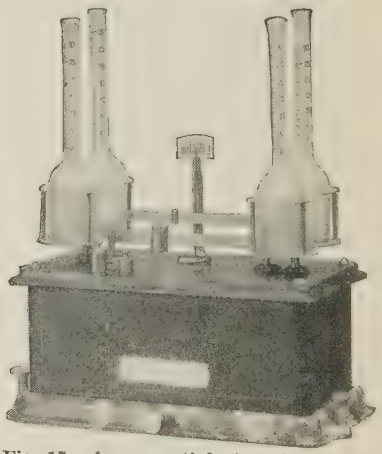


Fig. 17. A very satisfactory four-bottle cream test balance

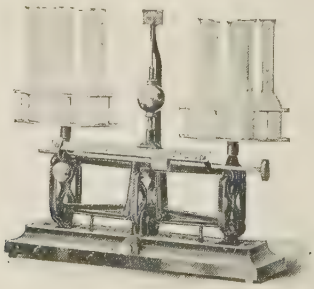


Fig. 18. A twelve-bottle cream test balance sensitive to at least .1 gram

Balances of large capacity and holding a large number of bottles are not as sensitive as balances of small capacity and holding a few bottles only. Other factors being the same, the one-bottle scale is the most accurate scale. However, two-bottle, four-bottle and even twelve-bottle scales, if properly constructed, in good working

condition and operated carefully, answer all practical purposes; they are sufficiently sensitive for this work and their relatively large capacity simplifies the cream testing problem and avoids unnecessary expense.

The balances should be kept dry and protected from corrosive influences such as sulphuric acid, salt, etc. During operation the scales should not be exposed to drafts and the weighings must be made accurately. After the bottles are placed on the scales, the scales should be properly balanced before any cream is transferred into the bottles. If any cream is spilled on the balance it should be removed before the weighing is completed. Mark each bottle with a number and record this number on the test sheet opposite the name or number of the respective patron.

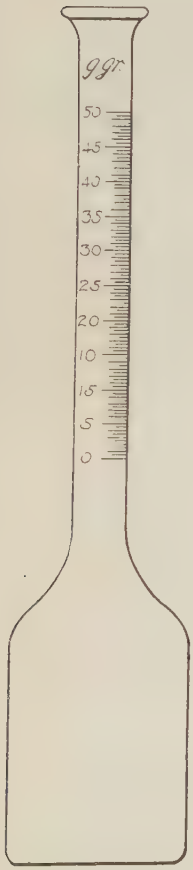


Fig. 19. The 50 per cent. nine gram short-neck Standard cream test bottle

Cream Test Bottles

Use standard nine gram 50 per cent. cream test bottles. The divisions represent .5 per cent., 1 per cent. and 5 per cent. The 5 per cent. divisions bear a figure to the left of the graduation. Two styles of these bottles may be used, short-neck bottles and long-neck bottles. For further details regarding standard cream test bottles see Agricultural Experiment Station Circular No. 41.

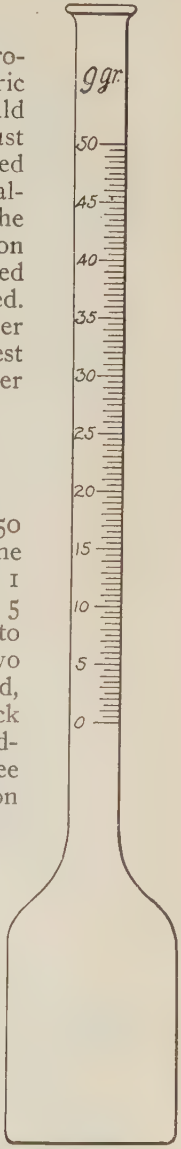


Fig. 20. The 50 per cent. nine gram long-neck Standard cream test bottle

Adding the Acid

Commercial sulphuric acid, specific gravity 1.82 to 1.83, should be used. The amount of acid to be used varies with the temperature and richness of the cream, averaging about eight to twelve cubic centimeters. The most satisfactory guide, indicating the amount of acid needed, is the color of the mixture of acid and cream immediately after shaking. Add acid until, when properly shaken and all the white curd has disappeared, the mixture has a coffee-brown color. A light brown color shows that more acid is needed. A black color immediately after shaking indicates too much acid.



Fig. 21. The acid dipper for testing cream

When adding the acid, the bottle should be held in an inclined position and should be revolved once. In this way the acid washes the neck free from particles of cream and curd.

After the acid is added the bottle should be shaken carefully by giving it a rotary motion. Care should be taken not to spill any of the contents. In case of spilling, the test should be rejected and made over.

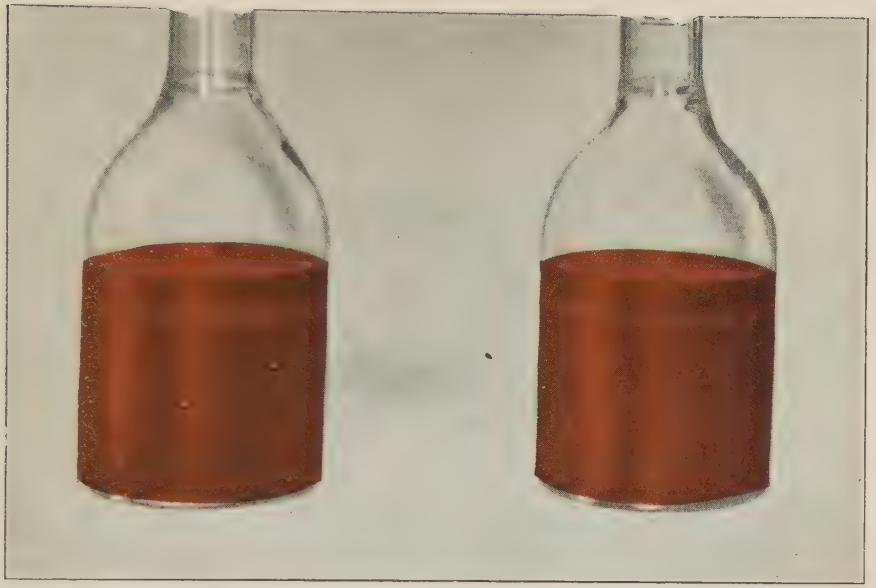


Fig. 22. Showing the desired color of the mixture of cream and acid immediately after shaking. Enough acid has been added when the mixture of acid and cream has the color of coffee with cream in it

Whirling and Adding Water

The bottles are now ready for the Babcock centrifuge. If there are not enough test bottles to fill all the pockets in the tester, the bottles should be so arranged as to balance the machine. Whirl for five minutes at the proper speed; one thousand revolutions per minute for a tester with a twelve inch diameter wheel and eight hundred revolutions per minute for a tester with an eighteen inch diameter wheel. Fill to the bottom of the neck of the bottles with hot, soft water, whirl for two minutes; fill to about the 45 per cent. mark with hot, soft water and whirl one minute. The temperature of the water added should be not less than 140 degrees F., and preferably near that of boiling water.

Reading the Test

Remove the bottles from the tester to the water bath, where they should remain in water at a temperature of 135 degrees to 140 degrees F. for ten minutes. Just before reading the test and when taking the bottles from the water bath, add a few drops of glymol. The glymol removes the meniscus or curve on top of the fat column, leaving a straight line which is sharply defined and readily seen.

Measure the fat column and record the per cent. of fat on the test sheet, opposite the test bottle number of the respective patron.

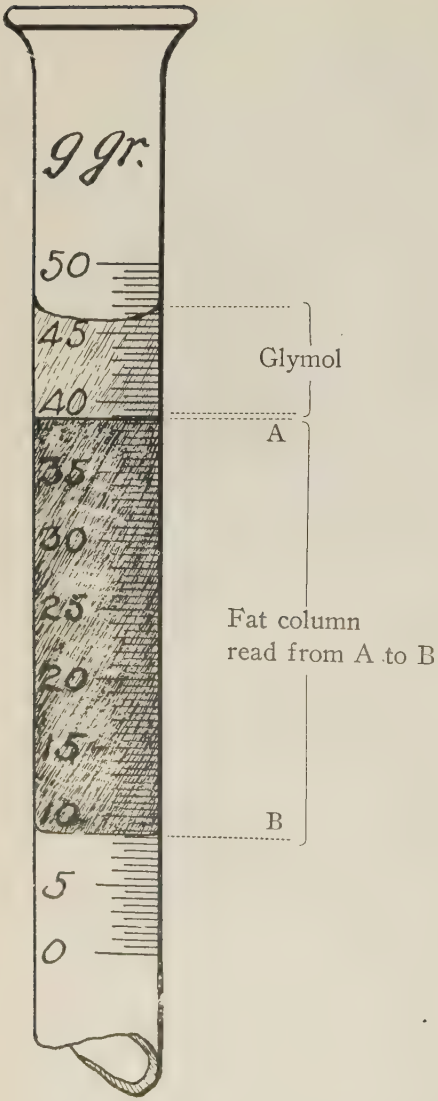


Fig. 23. The addition of a few drops of glymol on top of the fat column removes the meniscus and causes the formation of a straight, sharply defined line on the surface of the fat column. In this condition the test can be easily and accurately read



Fig. 24. The dividers assist in the accurate reading of the cream test

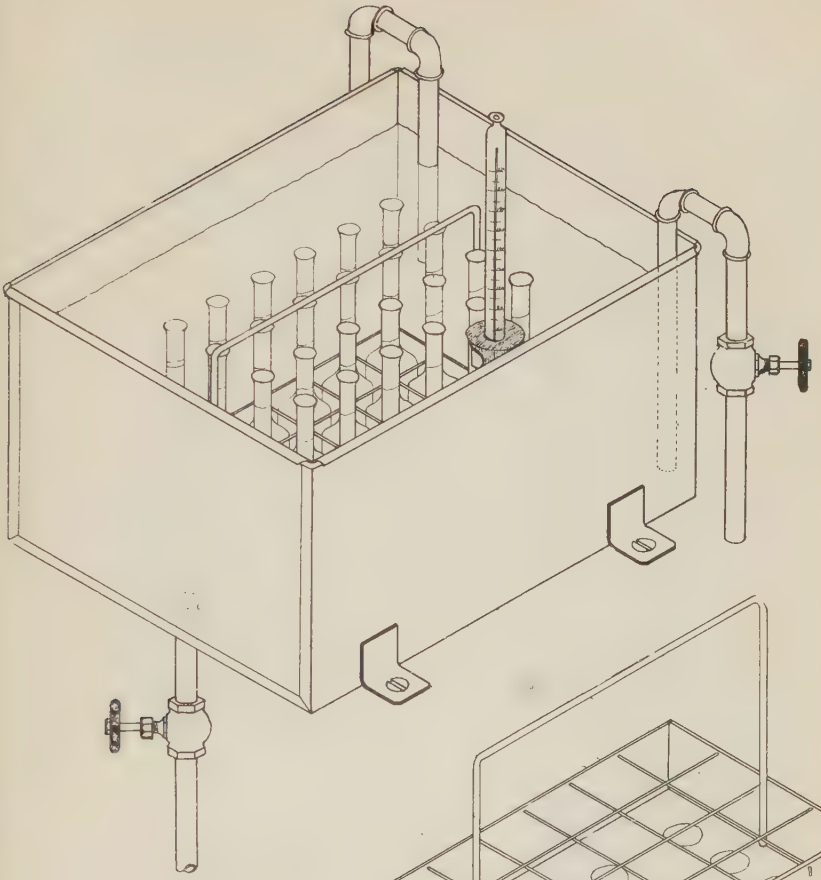


Fig. 25

Fig. 26

Fig. 25. The water bath, equipped with water and steam inlet, drain, thermometer, and basket holding twenty-four test bottles. Length fourteen inches, width eleven inches, height eight and one-fourth inches. A water bath of this size holds sufficient water to insure easy control of the temperature. The water should have a temperature of 135 degrees to 140 degrees F., and reach to the top of the fat column in the test bottles

Fig. 26. The basket, accommodating twenty-four test bottles. Length nine and one-half inches, width six and one-half inches

Purpose and Use of Glymol

Glymol is a high quality of white mineral oil. It is slightly lighter than butter fat and therefore floats on top of the fat column.

The object of using glymol is to remove the meniscus or curve present at the top of the fat column. This curve, owing to refraction of the light, is indistinct and renders correct reading difficult. When a few drops of glymol are placed on top of the fat column, the meniscus disappears and a straight, sharply defined line is formed between the top of the fat and the bottom of the glymol. In this condition the test can be read easily and accurately.

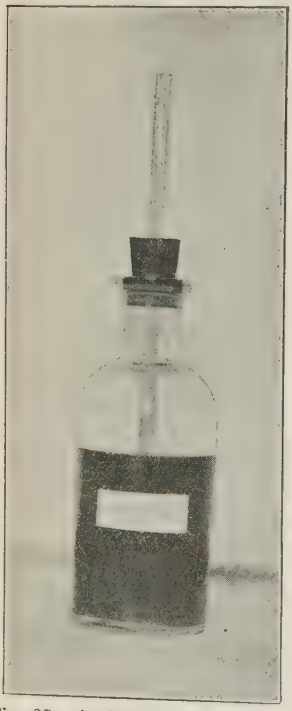


Fig. 27. A simple and convenient bottle for glymol

The glymol is best kept in a small bottle equipped with a perforated cork. The opening in the cork carries a glass tube, the lower end of which reaches to near the bottom of the bottle. In order to transfer the glymol to the test bottle, press the forefinger over the top of the glass tube. Raise tube and run the glymol from the tube, along the side of the neck of the test bottle, on the top of the fat column. If poured direct on the fat column, it tends to slightly mix with the butter fat, causing the surface of the fat column to be ragged and indistinct. A few drops of glymol (about one-half to one cubic centimeter) are sufficient. For the best results the glymol should be added immediately before reading. The glymol may also be conveniently transferred to the test bottle from a pipette or burette.

In the case glymol is not available the test should be read by including one-third of the meniscus in the reading. Glymol should be used in the reading of the cream test only; the milk test should be read without the use of glymol. If glymol were used in the reading of the milk test, the results would be too low. Experimental results have indicated that in the milk test the meniscus compensates for the loss of residual fat. It therefore must be included in the reading.

Glymol may be purchased in drug stores. Ask for white mineral oil.

Coloring Glymol

Some operators prefer the use of colored glymol. Glymol is best colored with alkanet root, which gives it a bright cherry color. Use one ounce of crushed alkanet root to one quart of glymol. Wrap the alkanet root in a small piece of cheese cloth and drop it into the vessel containing the glymol. The alkanet root may be removed from the glymol after twenty-four to forty-eight hours.

Alkanet root is sold by druggists at about twenty-five cents per pound.

Abnormal Appearance of the Fat Column

If the test has been made properly and in accordance with above instructions, the fat column is clear and has a golden yellow color.

Milky curd in and immediately below the fat column shows that not enough or too weak acid was used. A charred and dark curdy fat column indicates the use of too much or too strong acid. Abnormal tests should be rejected as the reading usually is indistinct and misleading.[1]

[1] For directions for avoiding the presence of foam on the surface of the fat column see "Abnormal Appearance of the Fat Column" in chapter on "Testing Milk," page 8 of this circular

TESTING SKIM MILK AND BUTTER-MILK

For testing skim milk and butter-milk use bottles with double necks, which are especially constructed for this purpose. The graduation of these bottles varies somewhat with the make of bottle. In some bottles the total graduation is .25 per cent. and the subdivisions represent .01 per cent. In others the total graduation is .5 per cent. and the subdivisions represent .05 per cent.

Measure the liquid into the test bottles with the 17.6 cubic centimeter pipette used for milk testing. In the case of butter-milk, particularly that derived from pasteurized, sour cream, the butter-milk should be stirred very thoroughly before sampling. This is necessary because the curd, which contains the bulk of the fat, separates out very quickly.

The test is completed in the same manner as that of milk, with the following modifications:

Special attention should be given when the bottles are placed into the tester. Test bottles in which the lower end of the funnel-neck extends perpendicularly along the side of the bulb to the bottom of the bottle, should be so placed that the funnel-neck faces the center of the tester, otherwise the fat rises into the funnel-neck. Test bottles in which the lower end of the funnel-neck extends diagonally to the bottom of the bottle should be so placed that the graduated neck faces the center of the tester. This will prevent excessive breakage of this type of bottles. The tester should run perfectly smooth in order to prevent excessive breakage, as these bottles are of very delicate construction.

Use about 20 cubic centimeters of acid instead of 17.5 cubic centimeters and whirl the bottles about twice as long as in the case of milk.

The amount of fat in skim milk and in butter-milk is, or should be, so minute, the fat globules are so small and the construction of the bottle is so crude, that it is difficult to secure very accurate tests of skim milk and butter-milk.

The results of testing skim milk and butter-milk should not be relied upon absolutely for accuracy, but they may serve as a convenient guide showing the operator, whether these by-products contain comparatively little or much fat. The above suggestion is offered on the basis of the results of a vast number of skim milk and butter-milk tests conducted by this department. In these tests the results were compared with the chemical fat estimations.

TESTING MILK ON THE FARM

The purpose of testing milk on the farm is to determine the production of butter fat by the individual cows in the herd.

Sampling the Milk

For all practical purposes, excepting official testing and experimental work, it is unnecessary to test milk samples daily. Composite samples may be taken daily and tested weekly and the pounds of butter fat determined by multiplying the weekly composite test with the pounds of milk produced per week. These samples are best taken with a milk thief, such as the Scovel milk thief, which may be conveniently suspended on the wall of the milk room close to the milk scales. Each sample is taken immediately after weighing the milk. A metal cap or glass stoppered bottle is provided for each cow and bears the number of the respective animal. These bottles are best placed in numerical order on a rack in close proximity to the scales. Each bottle should contain one preservative tablet.

Instead of taking composite samples daily, samples of two milkings per month may be taken and tested. In this case the monthly test is multiplied by the pounds of milk produced per month, in order to determine the pounds of fat of each cow per month.

Freshly drawn milk often contains a great deal of foam. Such milk should be allowed to stand for from thirty to sixty minutes before it is measured into the test bottles, in order to give the air incorporated during the operation of milking an opportunity to escape. Then the milk should be stirred thoroughly before pipetting.

Testing the Milk

The testing of milk on the farm is accomplished in exactly the same manner as described under the chapter on "Milk Testing" in

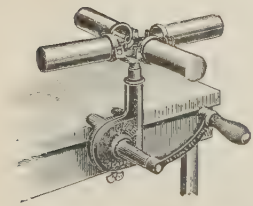


Fig. 28. A four-bottle hand tester, suitable for a small dairy herd

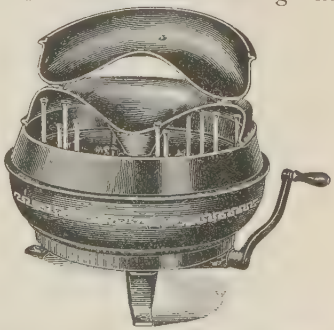


Fig. 29. A twelve-bottle hand tester, suitable for a good-sized dairy herd

this circular. Where steam or electricity are not available, and the herd is small, a hand tester may be used instead of the steam turbine or electric driven tester. The hand testers on the market range in capacity from two to twelve bottles. The speed is indicated on the crank of the tester. In order to avoid excessive chilling of the contents of the test bottles while whirling in the hand tester, it is advisable to fill the pockets holding the bottles, or the bottom of the castings of the tester, with hot water.

TESTING CREAM ON THE FARM

The purpose of testing cream on the farm may be two-fold. If sweet cream is sold for direct consumption, it is desirable to ascertain the proper richness of the cream. If the cream is sold to the creamery, the dairyman is in a position to check the accuracy of the creamery's tests.

In either case the directions given under the chapter on "Cream Testing" in this circular should be closely followed.

Since, on the average dairy farm, sensitive cream scales are usually lacking, and since there is no particular need of maximum accuracy, the cream may be measured into the test bottle with a 9 cubic centimeter pipette, instead of being weighed. In this case the pipette should be rinsed out twice with warm water and the rinsings transferred to the test bottle; otherwise the test will be too low.

If the cream is measured into the test bottles, care should be taken that the cream when measured, is not permeated with foam. Cream from the centrifugal separator should not be measured into the test bottle immediately after separation. Freshly separated cream contains considerable foam. If the measuring is deferred for at least thirty minutes after separation, the air thus incorporated can escape and a reasonably accurate test may then be obtained by first stirring the cream thoroughly before sampling.

It should be understood, however, that cream tests made by measuring the cream into the test bottles, are only approximate and are not entirely comparable with the more accurate way of weighing the cream, which is practised in the creamery.

ACKNOWLEDGMENT

Due acknowledgment is herewith made to The A. H. Barber Creamery Supply Company, The Creamery Package Manufacturing Company, Louis F. Nafis, The Torsion Balance Company, and The Wagner Glass Works for their kindness in supplying most of the electrotypes for this circular.

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 43

LaFayette, Ind., March, 1914

STALLION ENROLLMENT

I

ADVERTISING STALLIONS AND JACKS UNDER THE INDIANA STALLION ENROLLMENT LAW

D. O. Thompson

Section 9 of the Indiana Stallion Enrollment Law relates to the posting and advertising of stallions and jacks for public service. The many inquiries from stallion owners who have enrolled their stallions asking for information relative to their advertising matter, have lead the Board to prepare and publish this circular. This is in line with the policy of the Board, which is to be helpful in every way which will make for efficient administration of the law, intelligent interpretation of the same, and bring about cooperation of stallioners in the enforcement of its provisions.

SECTION 9

In order that the provisions of the section relating to the advertising of stallions and jacks for public service may be clearly in mind, Section 9 is given herewith:

"Section 9. The owner of any stallion used for public service in the state, shall post and keep affixed correct copies of the certificate of enrollment of such stallion issued under the provisions of this act, in conspicuous places, both within and upon the outside of his home stable and the stables or buildings where the stallion is used for public service and at any farm or place away from his home.

"Every bill or poster issued by the owner of any stallion enrolled under this act, or used by him or his agent for advertising such stallion, shall contain a correct copy of his enrollment certificate printed in bold faced type, not smaller than "small pica," and the first mention on said bill or poster of the name of the stallion, shall be preceded by the word, "pure-bred," "grade," "cross-bred," "standard bred," "non-standard bred," or "scrub," and the condition of soundness of said stallion indicated by the word "sound" or "unsound," in accordance with the wording of the enrollment certificate, and same shall be printed in type not smaller than the largest type in which the name of said stallion shall be printed on said bill or poster in any place whatsoever; and it shall be illegal to print upon any poster any misleading reference to the breeding or condition of soundness of said stallion, his sire or dam, or to use upon any such bill or poster, or in any other advertising matter whatsoever, the portrait of a stallion in a misleading manner; and every newspaper advertisement, post card, circular letter, or other form of advertising matter whatsoever, of any stallion for public service shall show the enrollment certificate number and state whether such certificate reads "pure-bred," "grade," "cross-bred," "standard bred," "non-standard bred," or "scrub," and the condition of soundness as stated in said enrollment certificate.

"All advertising that is found, upon inspection by the Secretary of the Board, to be at variance with the intent and purpose of this act, shall be suppressed or corrected until it shall comply with the purposes and provisions of this act, and the certificate of enrollment for which such advertising is issued, shall be temporarily revoked until such advertising is corrected, and fees charged for services of said stallion during such time shall be illegal and not subject to collection."

QUESTIONS ASKED AND ANSWERED

The following are some of the questions that have been asked relative to this section of the law, and the answers to them, as construed by the Board. Before writing to the Board, take this section, these questions and answers, to the printer, and with their aid, you should be able to draft any form of advertising which would be well within all the provisions of the law.

BILLS OR POSTERS

QUESTION 1.—How much and what advertising must a stallioner do to comply with the provisions of this section?

Answer.—Two correct copies of the certificate of enrollment must be posted and kept affixed, in *conspicuous places,* one upon the outside and the other upon the inside of each stable, or

other place, in which the stallion is used for public service. To make compliance with this provision easy for the stallioner, the Board has prepared correct copies suitable for posting and is supplying two of these free with each certificate. If the stallion is stood at several places, two copies of the certificate should be posted at each place. Typewritten or printed copies are permissible. Should the stallioner desire extra copies, similar to those supplied by the Board, they will be prepared and mailed postpaid ready for posting, at a cost of two for 40 cents; four for 60 cents; six for 80 cents; and eight for $1.00; money to accompany order in all cases.

QUESTION 2.—Does this law stop the "peddling" of stallions; i. e., driving stallions about the country and serving mares wherever the mare owner desires?

Answer.—It does not prohibit this practice, but necessitates the posting and keeping affixed of two correct copies of the certificate of enrollment in *conspicuous places* wherever the stallion is used for service *at any place or on any farm* away from his home as well as at the home stable. Stallioners who peddle stallions must be careful to fully comply with the provisions in this respect if they expect to use the privilege of moving their horses about the country, and escaping the penalties for violations of the provisions of this act.

QUESTION 3.—If correct copies of the certificate of enrollment are kept affixed as above specified, is other advertising required by law?

Answer.—No.

QUESTION 4.—What are the essential facts which must appear on every bill or poster?

Answer.—(a) A correct copy of the enrollment certificate printed in bold faced type, not smaller than "small pica." **(These words are printed in small pica.)**

(b) The first mention of the name of the stallion must be preceded by the word descriptive of his breeding as stated in the enrollment certificate, "pure-bred," "grade," "cross-bred," "standard bred," "non-standard bred," or "scrub."

(c) It shall also be preceded by the word "sound" or "unsound," in accordance with the facts set forth in the enrollment certificate.

(d) The facts under headings (b) and (c) shall be set forth in type not smaller than the largest type in which the name of the stallion appears at any place upon the poster.

(e) Such other facts relative to his breeding may be given as are in accordance with the facts set forth in the enrollment certificate.

(f) It is in line with good advertising to mention the terms of service, etc., and call attention to the provisions of the lien clause of the law, section 10.

(g) Owner's name, address, location of stands, etc.

QUESTION 5.—What must **not** appear upon any bill or poster?

Answer.—(a) An *incorrect* copy of the certificate of enrollment must not appear.

(b) Smaller type for the printing of the word "pure-bred," "grade," "cross-bred," "standard bred," "non-standard bred," or "scrub" preceding the first mention of the name of the stallion than that in which the name of the stallion appears at any place upon the bill or poster.

(c) A picture of a horse which is not a photograph or drawing of the stallion advertised must not be used; provided, however, that a stock cut such as is usually available in printing offices may be used on condition that the fact is stated directly beneath it, that it does not represent, or is not an exact likeness of the stallion advertised.

(d) Any misleading statement or reference to the breeding and pedigree or condition of soundness of the stallion, his sire or dam, must not be made.

Care should be exercised in this matter, as too frequently posters are used advertising stallions of grade of scrub breeding giving complete pedigree of the sire or dam, grandsire or granddam, or even more remote ancestors, so worded that the casual reader is misled into thinking that it is the recorded pedigree of the stallion advertised.

QUESTION 6.—May a stallioner use a bill or poster or other form of advertising matter to advertise his barn or business, not having upon it a complete copy of the certificate of enrollment of each of his stallions?

Answer.—Yes; provided, however, that he makes the statements upon the poster general only, and makes no specific reference to any particular horse. If any stallion's name is used, the facts as set forth in the answers to question 4, and the certificate of enrollment must be printed upon the bill or poster.

QUESTION 7.—Does the law require that a stallion be advertised by bill or poster?

Answer.—No; except that two correct copies of the certificate of enrollment must be posted and kept affixed as specified in the answer to question 1.

NEWSPAPER, CIRCULAR LETTER, POST CARD, LETTER HEAD, ETC.

QUESTION 8.—Does the law require that a stallion be advertised in any or all of the above forms?

Answer.—No; such advertising is optional with the stallioner, but if he uses any of the above mediums, he must see that they contain certain facts as set forth in the answers to the following questions.

QUESTION 9.—What are the essential facts that must be stated in every newspaper advertisement, circular letter, letter head, post card, or other similar form of advertising?

Answer.—(a) The word "pure-bred," "grade," "cross-bred," "standard bred," "non-standard bred," or "scrub," as set forth in the certificate of enrollment.

(b) The condition of soundness, "sound" or "unsound," and if unsound, the nature of the unsoundness, as stated in the certificate of enrollment.

(c) The number of the certificate of enrollment, as follows:

STALLION ENROLLMENT CERTIFICATE

NUMBER.....

(d) All other statements set forth must be facts and must not be misleading in any respect.

(e) If a cut is used which is not an actual picture made from a photo or drawing of the stallion, it must be stated that the cut is not a true likeness of the stallion.

(f) A complete copy of the certificate of enrollment is not required in these forms of advertising.

QUESTION 10.—May a stallioner call attention to his barn or business through the above mediums without the above facts set forth relative to each stallion?

See answer to question 6.

PENALTIES FOR NON-COMPLIANCE

QUESTION 11.—Does the law require that a stallioner comply with these requirements relative to his advertising and posting?

Answer.—Yes.

QUESTION 12.—What are the penalties attached to non-compliance to the advertising and posting provisions of the law?

Answer.—(a) The Board has power to and will suppress the advertising found at variance with the provisions of the law, its intents and purpose.

(b) The certificate of enrollment for the stallion for which the advertising is issued shall be temporarily revoked until such advertising is corrected.

(c) The stallioner has no protection under the lien clause (section 10).

(d) Fees charged for services of such stallions during such time, shall be illegal and not subject to collection.

(e) Violation of any of the provisions of this act is made a misdemeanor, and is punishable under the provisions of the law as found in section 12.

A WORD ABOUT ADVERTISING

In this day and age, the poster is but a fair medium for advertising a stallion, for the reason that but few farmers or mare owners will take the time or trouble while driving along the road to draw up at a roadside and read what a poster says, and but fewer still will be impressed by it.

As a medium for placing the facts relative to a stallion or breeding barn before the public, the newspaper advertisement, the hand or business card, the circular letter, the post card at the proper time, are all superior to the poster that is seen by the passerby but for a moment and is then gone from his mind. With these other mediums, the facts may be taken home by the prospective patron, who may file them for ready reference, or pass them on correctly as set forth to his friends and neighbors.

Stallion owners will do well to study carefully their advertising so that it may be correct and effective; in other words, so that it may pay.

ENROLLMENT TO DATE

At the time this goes to press, there have been opened in the Office of the Secretary of the Stallion Enrollment Board, applications for the enrollment of 4515 stallions. From all the indications that are at hand, this number may represent three-fourths, or perhaps not more than two-thirds of the stallions in the State. New applications are coming in daily. Certificates of enrollment will be issued as rapidly as accuracy and the rush of work in the office of the Secretary will permit, and the necessary proof relative to the breeding and ownership of stallions is supplied. **Delayed applications cannot expect immediate attention.**

SUGGESTIONS

In order to facilitate the work of this office, the following suggestions are offered to all who have not made application for the enrollment of their stallions.

1. Read carefully the instructions at the top of each application for certificate of enrollment. The blanks must be filled out in every detail, and the stallion owner should personally see to it that this is done. If the application arrives in an incomplete form, it will cause delay, correspondence, and anxiety on your part, as no horse can be used until enrolled. See that all the required facts are mentioned, and that each applicant signs his name in the proper place. Blanks are supplied free of charge upon application to the Secretary.

2. To establish the identity, and ownership by the applicant, of a pure-bred horse, it is necessary that

(a) The certificate of registry issued by the association recording him, accompany the application for his enrollment.

(b) The applicant's name appear upon the face of the certificate of registry as the owner; or, that a certificate of transfer signed by the secretary of the association issuing the certificate of registry, show that the applicant's name appears upon the records of the association as the owner of the horse. In such cases, the certificate of transfer and the certificate of registry must both be sent in with the application for enrollment.

If these are not sent with the application, request will be made that they be sent, which will result in delay, the application will be filed, and the certificate of enrollment will not be issued until they are received.

3. See that the veterinarian's certificate is filled in every detail and that he makes affidavit to same, and that the notary's signature and seal are complete.

4. Send all papers relating to one animal or more as the case may be, together with the fees, in one enclosure. When they are sent under separate cover, there is delay in bringing them together when a great bulk of mail is gone through, greatly increasing the work of the office and decreasing its efficiency.

5. When sending certificates of registry or fees, or other matter, plainly mark each piece with the name of the owner who is making application. This facilitates finding the papers on file. A letter or note relative to same should always accompany them.

6. When writing about a stallion which you have enrolled with this board, give his breed, name, and number of the certificate of enrollment which has been issued by this board. Also be sure to sign the letter. Several letters have been received and no name signed to them; therefore they remain unanswered.

7. The Board is compiling a list of stallion owners which has been secured from various places, and checking this list with the list of those who have applied for the enrollment of their stallions and who are complying with the provisions of the law. This should enable the Board to locate stallions which have not been enrolled. This list will soon be completed. The Board will do everything in its power to bring about a complete compliance with the provisions of the law, and will be pleased to receive signed lists of names of men who own stallions that have not been enrolled.

8. It is felt that cooperation of interested persons in the enforcement of the law is desirable in order that it may really become a force for improvement in horse breeding and production, and that the profits from raising horses may be made greater through increased information and consideration relative to the influence of purity of breeding and freedom from transmissible unsoundnesses.

This cooperation and support is a duty the stallioner owes to himself and to the horse breeding industry of his community and the State. The Board believes that all want to aid in producing superior horses in Indiana, and solicits your full and hearty cooperation. Mare owners as well as stallioners may be of assistance, if they will, by reporting cases of failure to enroll a stallion; by reporting cases of careless examinations and misrepresentations as by sending advertising which does or does not comply with the provisions of the law; by reporting cases in which posters are not kept affixed as required by law; and in many ways which will suggest themselves to those interested.

BENEFITS TO STALLIONER

Full compliance with the provisions of the law relative to advertising will

(a) Protect the stallioner from any prosecution to which he is liable if he does not fully comply;

(b) Give him full opportunity to exercise his rights under the lien clause as set forth in section 10 of the law. This clause is a particularly strong feature of the law, and deserves the careful study every stallioner and mare owner.

(c) Give each stallion the kind of label he is entitled to, upon e proofs which can be substantiated relative to his breeding; i. e., ıyone may know whether the stallion is pure-bred, grade, or scrub, shown by the records of standard registry associations.

(d) Give the man who complies absolute right to demand that his competitors comply and meet the various provisions of the law.

(e) Give each stallion a label as to condition of soundness; i. e., anyone may know whether a stallion has been reported as free from any transmissible unsoundness, or as unsound.

OFFICE OF THE BOARD

The office of the Board is located on the first floor of the Experiment Station Building, which is at the corner of Marsteller and State Streets, West LaFayette, Indiana. Address all correspondence to the Secretary of the Board.

MEMBERS OF THE BOARD

President, CHARLES W. HICKMAN, LaFayette, Indiana
Indiana State Board of Agriculture
Vice-President, C. M. MCCONNELL, Sheridan, Indiana
Indiana Draft Horse Breeders' Association
Secretary, D. O. THOMPSON, West LaFayette, Indiana
Animal Husbandry Department
Purdue University Agricultural Experiment Station

630.72 I39B NO 01 43

a39001 007396768b